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OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLII.—No. 3702] LONDON: FRIDAY EVENING, DECEMBER 24, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

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Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 4262

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Borough of Torquay Electricity Undertaking.

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TENDERS are INVITED for the CARRYING OUT of the following WORKS as one complete whole :—

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(2) Provision and Installation of One Rotary Wagon Tipper.
(3) Provision and Installation of One Railway Wagon Weighbridge with Weighhouse.
(4) Electric Capstan and Fairleads.
(5) System of Coal Conveying Plant between Railway Siding and Power Station.
(6) One 1000-Ton Concrete Storage Bunker.

Copies of the specification may be obtained on application to the undersigned, together with a deposit of £1 1s., which will be returnable upon the receipt of a bona fide Tender.

Additional copies may be obtained at the price of 10s. 6d. per copy, not returnable.

Tenders will only be considered from firms willing to undertake as main contractors the whole of the works covered by the specification.

The Corporation does not bind itself to accept the lowest or any Tender.

H. F. G. WOODS, M.I.E.E., A.M.I.M.E.
Electricity Offices, Upton Valley, Torquay. 4275

Oakengates Urban District Council.

WATERWORKS.

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The general conditions, specification and form of Tender may be obtained by the manufacturer or contractor at the office of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Pumping Plant," must be delivered at my offices, Oakengates, Salop, on or before 10 a.m. on Tuesday, the 8th day of February, 1927.

The Council do not bind themselves to accept the lowest or any Tender.

(Signed) J. A. HOLMES, Solicitor, Clerk.
Clerk's Office, Oakengates, Salop. 4276

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. OVERHEAD TRANSMISSION LINE MATERIAL and CABLES.
2. WATER CRANES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Overhead Transmission Line Material and Cables," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 7th January, 1927.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 10s. for each copy of Specification No. 1 and 5s. for each copy of Specification No. 2.

Copies of the drawings may be obtained at the offices of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD, Managing Director.
91, Petty France, S.W. 1.
16th December, 1926. 4273

SITUATIONS OPEN

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ENGINEER-IN-CHARGE for Workshops and Garage, operating fleet comprising both petrol and steam wagons.—Address, giving fullest particulars of qualifications and experience, 4280, The Engineer Office. 4280 A

The Engineer

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SITUATIONS OPEN (continued)

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SITUATIONS OPEN (continued)

MECHANICAL DRAUGHTSMAN, Box No. 4125.—The POSITION advertised for under this box number has been FILLED. 4267 A

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE SEVERAL DRAUGHTSMEN with Blast-furnace and Steel Works experience.—Apply in writing to CHIEF ENGINEER, c/o above. 4238 A

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CIVIL AND MINING ENGINEER, with British and foreign experience in railway quarrying and mining work, public school, also engineering diploma, is now available for RE-ENGAGEMENT at home or abroad.—Address, P2583, The Engineer Office. P2583 B

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FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 338, High Holborn, W.C. (Opposite Gray's Inn-road). Ex.

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KING'S PATENT AGENCY, Ltd. (Director, B. T. KING, C.I.M.E., Registered Patent Agent, G.B., U.S., and Canada). Inventions advice handbook and consultations free. — 146a, Queen Victoria-street, London, E.C. 4. 40 years' refs. 'Phone: Central 682. 3616 H

OPPORTUNITY TO ACQUIRE VALUABLE PATENTS.—ENGINEER, having fully developed and patented in important countries efficient ELECTRIC GAUGE to indicate contents of tanks—automobiles, bulk storage, ships, aircraft, reservoirs, &c.—will NEGOTIATE MANUFACTURING RIGHTS or SELL OUTRIGHT. Working models seen by appointment.—Address, 4248, The Engineer Office. 4248 H

THE PROPRIETOR of BRITISH PATENTS Nos. 137,121 and 141,137, both dated January 9, 1919, relating to "Improvements in Apparatus for Measuring Difference Between Fluid Pressures and Applicable to Fluid Velocity Meters and the like," and "Improvements in Means for Controlling Combustion in Steam Generator and like Furnaces," respectively, is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical workings in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4218 H

THE PROPRIETOR of BRITISH PATENT No. 129,872, dated January 20, 1919, relating to "Improvements in Automatic Sprinkler," is DESIROUS of ENTERING into ARRANGEMENT by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to Mr. B. SINGER, Woolworth Bldg., New York City, N.Y., U.S.A. 4219 H

THE PROPRIETOR of BRITISH PATENT No. 214,705, dated January 22, 1923, relating to "Improvements in the Regulation of Combustion," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4221 H

THE PROPRIETOR of BRITISH PATENT No. 178,507, dated January 4, 1921, relating to "Improvements in Electric Motor Controllers," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4220 H

THE PROPRIETOR of BRITISH PATENTS Nos. 205,000, dated January 25, 1922, and 213,397, dated February 24, 1923, relating to "Improvements in Electric-driven Pump and Blower Sets," and "Improvements in Oil Burner," respectively, is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical working in Great Britain.—All inquiries to B. SINGER, Steger Building, Chicago, Illinois. 4266 H

THE PROPRIETOR of BRITISH PATENT No. 214,749, dated February 5, 1923, relating to "Improvements in Lathes," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4263 H

THE PROPRIETOR of BRITISH PATENT No. 175,186, dated February 3, 1921, pertaining to "Improvements relating to the Cleaning and Ginning of Cotton," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 4264 H

THE OWNERS of BRITISH LETTERS PATENT No. 211,845, relating to "Multi-stage Axial Flow Pumps;" No. 236,839, relating to "Bore-hole Pumps;" and No. 216,722, relating to "Pump Bearings," are prepared to receive TENDERS for the MANUFACTURE of the APPARATUS in Great Britain or to consider APPLICATIONS for the GRANTING of LICENCES thereunder.—Applications in the first instance should be addressed to KILBURN and STRODE, 31, High Holborn, London, W.C. 1. 4265 H

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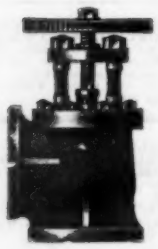

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A Seven-Day Journal

The Cairo-Karachi Air Service.

ON Saturday morning, December 18th, a de Havilland aeroplane, carrying two pilots, an engineer, a wireless operator, the Director of Civil Aviation, and three other passengers, left Croydon for Egypt. This aeroplane, a DH 66, fitted with three Bristol "Jupiter" engines, is the first of five which have been or are being built for Imperial Airways, Ltd., for its Cairo-Karachi air service. That service, under contract with the Air Ministry, is to be maintained for a period of five years at a subsidy of £96,000 a year. Passengers, mails and goods will be carried. The first machine will leave Cairo on January 12th, and thereafter for the first three months a fortnightly service both ways will be maintained as far as Basra. The full journey between Cairo and Karachi will occupy four days, and during the whole of it the machines will be in communication with meteorological and wireless stations which have been established along the route. It is hoped ultimately to extend the service from Karachi to Calcutta and thence by means of flying boats to Singapore. As an article which appears elsewhere in this issue shows, Karachi, already a military air station, will, in addition to becoming the Indian terminus of the service from Cairo, also be a principal station for the commercial airship service which is to be begun in the course of a year or so. A large shed, a mooring tower, and other works are now being erected on the site.

Proposed New Cruisers for the United States

FOR some time past dissatisfaction has been expressed in political circles in the United States regarding President Coolidge's national defence policy. In particular, attention has been directed to the naval aspect of the question, and repeated emphasis has been laid on America's alleged inferiority to this country in the matter of cruisers. On Saturday of last week, December 18th, Senator William Butler, Chairman of the Naval Committee, brought the subject to a head by introducing a Bill to authorise the construction of ten scout cruisers, each of 10,000 tons displacement, at a total cost of £21,000,000, exclusive of armour and armament. The draft Bill contained a clause to the effect that the President should be empowered to suspend the proposed new construction in whole or in part in the event of another conference on the limitation of naval armaments being called. Some authorities hold that Senator Butler's move has been dictated by those holding "big navy" views. Others, however, argue that he has introduced his Bill in collaboration with the President himself, with the object of forcing Great Britain's hand and compelling her to consent to a new conference on the limitation of naval armaments.

The Trans-Saharan Railway.

THE exploration work which has been carried out in the Sahara during the past two or three years, the number of journeys that have been undertaken across the desert by means of motor cars, and the successfully accomplished task of the three missions which recently left North Africa and proceeded by three different routes to the Niger, have given prominence once more to the scheme for constructing a railway cross the Sahara. The necessity of this work has long been insisted upon by the Conseil Supérieur de la Guerre, which presented a plan to the French Government two years ago, but the scheme has since been held up in the hope that the problem would be solved in a more economical manner by motor traction. Exploration work, mainly with motor vehicles, has shown that the difficulties in the way of organising transport in the desert have been exaggerated. The military authorities affirm that their plan, which has been developed in all its details, is the only one which will consolidate the vast French Empire from the northern frontier to the Niger. A normal gauge railway, they hold, can alone deal with the traffic and divert it directly across the Mediterranean instead of carrying it round by the Atlantic. The railway would start from the south of Algeria and proceed to Tanezkouft, south of the Hoggar, and it would then bifurcate to Gao and the Niger in one direction and to Lake Chad and the Belgian Congo in the other. This railway, it is claimed, would enable France to obtain from Central and West Africa practically all the raw material she would require. The scheme was brought up again during the debate on the Budget estimates, and it will probably figure in the proposals to be presented shortly for the putting in hand of a vast programme of colonial development.

German Airship Patents.

ON Thursday of last week, December 16th, the Anglo-German Mixed Tribunal heard a case brought by a German company, the Luftfahrzeug, against Vickers, Ltd., in which a claim for £100,000 was made for the use of the German company's patents, material, experience and knowledge with respect to the construction of non-rigid airships before the war. An agreement had, it was stated, been entered into between the German company and Vickers for the exploitation of the patents, and experienced men had been sent over to assist with the practical work. A German witness, giving evidence in favour of the company, was asked when and why the Germans abandoned the building of non-rigid airships. He replied that the construction of these vessels was stopped because of the shortage of raw rubber during the war and not because of any deficiency in the standard of their performance. The Tribunal eventually decided that the German company had failed to bring its claim within the terms of the treaty, and that the Tribunal could not deal with it. The claim was therefore dismissed, and the claimants were ordered to pay £100 costs. Vickers counter claimed against the company for £12,597, being £8268 for money prepaid for the purchase of an airship ordered before the war and not delivered and £4329 prepaid for certain articles, which could not be delivered owing to the war. Under this claim the Tribunal awarded Vickers £11,991, plus accrued interest, and £100 costs. A counter claim by the German company for £6030 for royalties with respect to airships built by Vickers from the claimants' plans and patents was struck out.

Palmer's Reconstruction Scheme.

PARTICULARS of the reconstruction scheme which has been put before the debenture stockholders and shareholders of Palmer's Shipbuilding and Iron Company, Ltd., are now available. The board of directors states that during the last five years of acute trade depression the firm has sustained severe losses. In order to strengthen the balance sheet and to accelerate payment of dividends, it is proposed to reduce the issued share capital of the company from £1,454,080 to £513,520, by cancelling the capital which has been lost or is unrepresented by available assets. The suggestion is that the usual £1 shares of the company should be reduced to 5s., and that in return for an extra 2½ per cent. dividend, and a 10 per cent. premium on winding up, holders of usual preference shares should renounce all arrears of preference dividend to the end of 1926 and give up cumulative participating rights. It is further proposed to create a new 6 per cent. first debenture stock up to an amount not exceeding £650,000 in exchange for the present 5 per cent. stock. Fresh share issues will make the company's capital £2,000,000. The holders of consolidated stock are asked to grant a moratorium for three years, during which, given favourable trade conditions, the company should retrieve its position. It is pointed out that Palmer's have been very successful in obtaining a good share of the shipbuilding orders recently placed, it being estimated that such orders represent an aggregate sum of no less than £2,000,000. Should the reconstruction scheme outlined be adopted, it is hoped that the company will be able to continue its business with profit.

Time-keeping in Shipyards.

IN view of that renewed activity in the shipbuilding industry which is the immediate result of the many recent orders and the early prospect of good supplies of material, a joint effort on the part of employers and shipbuilding trade unions is being made to better the time-keeping of the men employed in the shipyards. When the 47-hour week was agreed to in November, 1918, it was jointly understood that good time-keeping should be observed in all branches of the industry, in order that the largest output might be both secured and maintained. This agreement was reaffirmed in a memorandum of 1919, and again at last year's joint conference. On Monday last, December 20th, notices calling the attention of workmen to the report of the joint committee of employers and unions on this matter, and citing the above mentioned memorandum, were posted in the various shipyards and ship-repairing establishments throughout the country. The final section of the notice reads as follows:—"From January 1st, 1927, workmen in these works will be required to remain at their work right up to the time of stopping, and be there to begin work promptly at starting time." It is to be expected that the helpful co-operation between the employers and the union representatives, which has been a feature of the recent joint conferences, will again prevail to secure a better co-operation of the men in the yards in attaining the desired end. Should difficulties arise it is probable that conferences between individual employers and the yard representatives of the men will be instituted.

Heavy-Oil Engine Working Costs.

IN the newly issued report on Heavy-Oil Engine Working Costs (1925–1926), which has been prepared by the General Committee of the Diesel Engine Users Association, figures are given for the working costs of thirty-seven home stations and nine overseas stations. The analysis of costs tabulated in order of station output, in the case of the home stations, is also shown in graphical form. Comparison is made between British and American costs. The Committee emphasises the value of figures from stations in which oil engines are run in conjunction with other prime movers, or where bulk supply is taken. During the year under review six new engines were installed in the forty-six undertakings represented, and the average size of unit was 750 brake horse-power, as against 500 brake horse-power last year. The average cost per unit generated improved, in the case of the home stations, from 0·806d. last year to 0·799d. this year, notwithstanding a slightly increased price for fuel oil and a less favourable running plant load factor. For the thirty-seven home stations the average cost of 0·799d. per unit generated is made up of the following percentages:—Fuel, 48·4 per cent.; lubricating oil, 7·13 per cent.; water (including treatment), 1·38 per cent.; stores, 0·88 per cent.; wages (running staff), 25·10 per cent.; repairs and maintenance, 17·11 per cent.; total, 100 per cent. Assuming the average gross calorific value of the fuel used as 19,500 B.Th.Us. per pound, then the overall thermal efficiency of the 46 stations under review employing 177 engines, varying in size from 1125 to 60 brake horse-power, and run at an average running plant load factor of 60·1 per cent., was 24·15 per cent. The average fuel consumption per unit generated was 0·725 lb., and the average lubricating oil used per unit generated 0·00154 gallon. As the report contains several suggestions for improving the value of these returns, we await its discussion by the members with interest.

New Atlantic Liners for Germany.

THERE are clear signs that we are entering a renewed period of competition in the passenger and cargo trade between Europe and America. Not only are developments foreshadowed in the shipbuilding programmes of British and American-owned lines, but recent events have gone to show that Germany, although not now owning the largest liners, will again make a bid for a further share in the Atlantic traffic. During the year the third ship of the Ballin and Deutschland class, the Hamburg, was placed in commission by the Hamburg-American Line, and early in the spring of 1927 she will be followed by her sister ship, the New York. Both liners have been built by Blohm and Voss, of Hamburg, and are 600ft. ships, with a gross tonnage of approximately 20,000, propelled by geared turbine machinery. Both passengers and cargo are carried. A distinctive feature of the design is the adoption of anti-rolling tanks embodied in bulges, which extend for a length of about 180ft. amidships. It is stated that this arrangement has decreased the roll of the ships to one-third of that normal to a vessel of similar size without the tanks. The news that the Norddeutscher Lloyd Company will shortly order two further ships of the "Columbus" class of 46,000 tons, with a designed speed of 26 knots, marks a departure from the post-war Hamburg-American practice of smaller ships and lower speeds carrying both passengers and cargo. The new vessels, it is stated, are due for delivery in the early part of 1929, and should place their owners in a comparatively strong position as regards tourist traffic.

Proposed High-speed Service to Australia.

THERE has recently been some prominence given to a proposal to establish a fast steamship service between this country and Australia on the lines followed on the North Atlantic route. On this subject Mr. I. C. Geddes, presiding on Friday of last week, December 17th, over the annual general meeting of the Orient Steam Navigation Company, expressed himself in clear terms. Such a service, making use of 22-knot steamers, he said, could only be maintained with the assistance of a formidable subsidy. The backbone of the Australian trade was wool and wheat, not passengers or mails. A passenger list of reasonable dimensions might be obtained now and again, but for many months of the year the company's vessels had to run with only a handful of long-distance saloon passengers. For most of the company's passengers low fares were more attractive than high speeds. For high speed transportation between Britain and Australia he believed the future lay in the air rather than on the ocean.

The Railwaymen's Week.

ON Tuesday, December 21st, representatives of the railwaymen's trade unions met the railway managers at 35, Parliament-street, to ask that the guaranteed week, which was suspended during the coal strike, should be restored. A three hours' conference took place, and although no decision was reached on the question of granting the men's demand, it is understood that the railway companies gave sympathetic consideration to the claims of the unions. The demand raises, it appears, some difficult questions with regard to the working of short time at some centres, and the employment at full weekly wages of all men at other centres where as yet normal working has not been resumed. It is believed by the unions that an amicable working settlement may be arrived at, but that it may be necessary to defer a reintroduction of the "guaranteed week" for a short time until certain questions relating to the reinstatement of men and temporary measures of economy have been settled. The meeting on Tuesday was, it appears, characterised by a friendly tone and proceedings were adjourned without fixing a further meeting.

The Sukkur Barrage Irrigation Project, 1920.

By F. W. WOODS, C.I.E.

THE river Indus and its tributaries, the Punjab rivers, after issuing from the Himalayas, are confined, for a distance of 150 miles or so, between upland plains which are well above the reach of the highest floods. Between these uplands the rivers flow in valleys several miles wide, in deltaic formation, *i.e.*, along the top of ridges formed by the alluvial deposits from their own floods. As the rivers converge towards their confluences the uplands narrow to points and vanish, and thereafter the rivers remain in deltaic formation for the rest of their courses. These formations lend themselves easily to primitive methods of irrigation by "inundation canals," which are usually old creeks or abandoned natural channels of the rivers, into which the rivers are enabled to spill in the flood season only. The irrigation of the uplands calls for a higher degree of scientific engineering, the flow of the rivers being ponded up to heights of from 10ft. to 15ft. above the levels of the low-water season, and diverted into high-level canals of perennial flow conducted to the uplands.

Wherever these rivers are, or have been, in deltaic formation—as the Indus is throughout Sind—they have changed their courses by "avulsion" on numerous occasions. The Indus, at one time in the past, flowed down the East Nara Valley, and at another, down the West Nara—see Fig. 1. In the year 1906 it shortened its course by about 12 miles, at a distance of 16–27 miles downstream of Sukkur, and about the same time it wiped out the town of Dera Ghazi Khan (D.G.K. on map) in the Punjab, by steady lateral erosion. Hitherto the irrigation of Sind has been entirely by means of inundation canals, and highly remunerative.

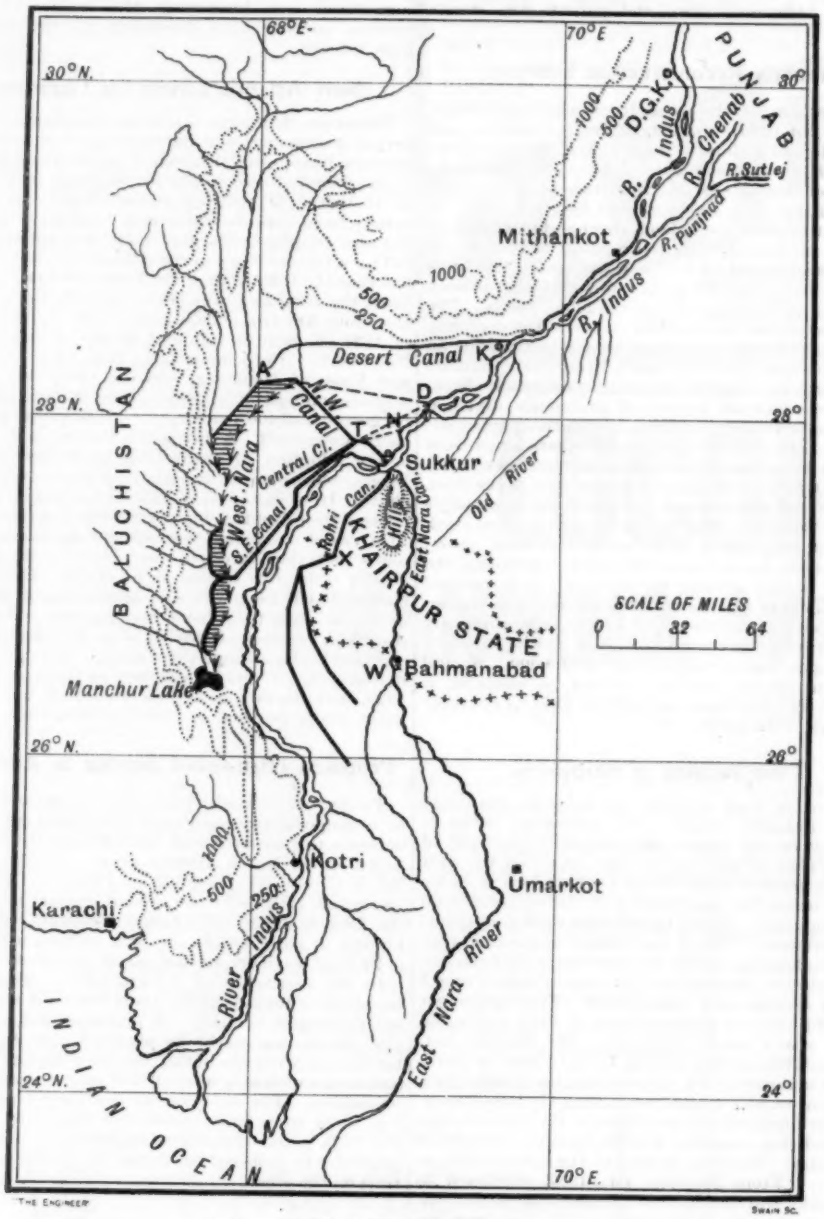


FIG. 1—MAP OF SIND

The Birth of a Fallacy.

The five-year period 1898–1902 was one of scanty rainfall and scanty river flow throughout India. Scarcity of food crops and famine resulted, conditions which formed an incentive to irrigation enterprise. The Government of India appointed an expert "Irrigation Commission" to advise on such enterprise, and as regards Sind an "Indus River Commission" was appointed to study the hydraulics of that river. The irrigation of Sind depended entirely upon the average water level of the river during the four months of the flood season, June to September. During the cycle of drought, 1898–1902, this average water level was about 1ft. below normal, *i.e.*, 195·4 instead of 196·4 at Bhakkar. At the same juncture the new "Colony" canals of the Punjab, fed by the Chenab and Jhelum rivers, had entered upon a career of remarkable prosperity. The idea arose in Sind that the scanty flow of the Indus in those years was due to the increased withdrawals of water by irrigation canals in the Punjab, and that the only remedy for that was to build a barrage across the river at Sukkur to pond up the water to normal levels. Thus the barrage project was first mooted by Mr. Dawson, of the Indus River Commission, in 1902. The "dry" cycle, 1898–1902, was followed by a "wet" cycle, 1903–1906, during which the water levels of the Indus rose nearly 1ft. above the normal. This would have exposed the fallacy of the barrage idea, but for an accident, which confused matters. In 1906 an avulsion of the Indus, about 20 miles downstream of Sukkur (Fig. 2), shortened its course by 12 miles, and the bed and water levels of the river at Sukkur Outfall Station were thereby lowered by about 2ft.—see Table I. above. The reports of the Indus River Commission made no mention of this, and the fact that after 1906 the water levels at Sukkur, even in "wet" years, were lower than had previously been regarded as normal, impressed even engineers with the idea that this subsidence of levels was *somehow* due to increased withdrawals of water by Punjab canals from the tributaries of the Indus.

TABLE I.

Discharge, (cusecs.)	At Sukkur Outfall Station.					
	Water surface levels.			Mean bed levels.		
	Period 1901–05.	Period 1911–19.	Fall.	Period 1901–05.	Period 1911–19.	Fall.
200,000	193·81	191·09	2·72	181·81	178·60	3·21
300,000	194·57	192·31	2·26	180·07	178·60	1·47
400,000	195·96	193·95	2·01	179·56	178·00	1·56
500,000	196·88	195·10	1·78	177·93	174·25	3·68
Average			2·24			2·23

A project was prepared for the construction of a barrage on the Indus, just upstream of Sukkur, where the river forces its way through a narrow gorge in an isolated outcrop of low hills on either side of the rock island of Bhakkar. The project, which also provided for the construction of the Rohri Canal, offtaking from the left flank of the barrage, was submitted to the Secretary of State for sanction in 1912. He referred it for advice to a committee of experts in London, who, in 1913, advised against it, mainly on the ground that no urgent necessity had been shown for heavy expenditure on a project that did not promise to be financially remunerative.

Investigations by the Sind engineers had meanwhile shown (see Table I.) that the visible subsidence of water levels at Sukkur did not connote any diminution of volume of river flow in Sind; but fallacies die hard. In September, 1915, the Bombay Government urged that, "although it was difficult to prove any direct effect of the Punjab withdrawals on the river at Sukkur, there was reason to believe that it might have a prejudicial effect at the beginning and end of the flood season, and that Sind ought to be insured against that by a barrage." In that same year, 1915, a Bombay official of the Political Department was appointed to be member of the Viceroy's Council in charge of the portfolio of Public Works, Revenue and Agriculture, a circumstance which facilitated the passage to sanction, by the Secretary of State for India, of projects like the Bombay Back Bay reclamation project and the Sukkur barrage project of 1920. Eminent officials—not engineers—had become obsessed by the barrage idea, and regarded expert advice as a matter of secondary importance.

The Barrage Project of 1920.

This is a project for a barrage to be built at a place three miles downstream of the Bhakkar gorge. We may call this Site II., as distinguished from Site I., of the 1912 project. The new project, included provision for the construction of five great perennial canal systems, viz., two on the left bank, and three on the right bank, of the river. Its cost was estimated at £12,000,000, including £4,000,000 for the barrage alone. The Secretary of State for India sanctioned this project without taking any independent expert advice on it.

A peculiar feature of the case is that the engineers who prepared this important project, for a river barrage and vast perennial canal systems, had had no previous experience of public works of this kind. The only engineer with a knowledge of perennial canals who advised the approval of this project, has since, it is believed, modified his opinions of its technical merits, during the past few years.

The designs of the project were avowedly based on those of the most modern perennial canals of the Punjab, viz., those offtaking from the rivers Chenab and Jhelum; but in a lecture which I had the honour to deliver at the Royal Society of Arts in June, 1922, I pointed out that the designs of the project, were in many essential features, not in accordance with modern perennial canal practice in the Punjab.

Recently, in the issue of this journal, dated August 20th, 1926, Mr. E. S. Bellasis has expressed complete approval of the Sukkur barrage project. He does not appear to have read the report on the project nor the reports of the Indus River Commission, but seems to rely mainly on arguments used in a Joint Note written in 1923 by Messrs. Gebbie and Musto, in reply to my criticisms. Hitherto this Gebbie-Musto Note has been protected by official "privilege," but now, thanks to Mr. Bellasis' article, it is permissible to discuss what he has given publicity to.

It is relevant to note at the outset that Mr. Bellasis' professional experience has been derived chiefly from employment on "inundation canals," similar to the existing canals of Sind, which the barrage project aims at scrapping, and, to the best of my belief, has never been employed on the modern perennial canals of the Punjab.

Bellasis on Avulsions.

Mr. Bellasis writes at great length, but with little consistency, on river avulsions. His internal contradictions are strung together below, after rearrangement of the scattered beads (*ipsissima verba*) in suitable juxtaposition. According to him:—

(*a*) The tendency of a river is to work itself into bends and so to reduce its gradient by increasing its length. The tendency of a river is to cut off pronounced bends and so to increase gradient by shortening length.

(*b*) Fig. 2 shows an avulsion which, in 1906, cut off a bend to the right, 17 miles below Sukkur. Bends tend to occur alternately to the right and to the left, so the next avulsion should cut off the Sukkur bend to the left; but this is most improbable.

(*c*) Avulsions are common where a river forms pronounced loops, as on the Mississippi. There are pronounced loops on the Indus, but avulsions cannot occur there.

(*d*) To the non-professional mind there is always confusion between a flood and an avulsion. A high flood may produce an avulsion like that of 1906 below Sukkur; but there is a distinction between the two phenomena, which is a professional secret.

(*e*) An avulsion can only be caused when an embankment is breached by a flood. Breaches of the embankments of the Indus never cause avulsions.

(*f*) In China, a river, embanked on both sides, raised its bed by silt deposits and an avulsion resulted, On the Indus, however, embankments cannot produce such an effect.

(*g*) Avulsions occur, in spite of embankments, on the Mississippi and in China, but not on the Indus. The avulsion of 1906 below Sukkur could have been prevented by embankments.

(*h*) The Indus above Sukkur has no known tendency to move south. In the 20 miles above Sukkur the Indus flows due south—see Fig. 2.

It is sufficient comment on the foregoing speculations to point out that, in the design of the Sukkur barrage, the permissible afflux has been limited to 1ft., and the cost of the work thereby enormously increased, simply through fear that a higher afflux would involve serious risk of avulsion. If embankments had been relied on to obviate such risk, the permissible afflux could have been increased to 8ft., as in the case of the Nile barrages in Egypt. On Mr. Bellasis' map—Fig. 2—I have marked three dotted lines, A S, A H, P R. Nothing that he has written affords any reason for his belief that the river cannot short-cut itself along any of these lines, even if no barrage be built at Sukkur, as it did along the line S T in 1906.

The river bend to the right of S T was 23 miles long, but the avulsion of 1906 shortened it to 11 miles. The Sukkur bend A M H is 30 miles long, whereas the straight line A H is only 13 miles long. The normal declivity of the river being half a foot per mile, the difference of water level between A and H is 15ft., so that A H has a potential declivity equal to double the normal. Prior to 1906 the bend near S T set up a flood afflux of about 6ft. at S and raised bed and water levels, even at Sukkur, 16 miles upstream—see Table I.—by 2ft. The Sukkur bend must have similar effects at M and A—Fig. 2—upstream of Sukkur. Add to this the effect of congestion at the Bhakkar gorge and obstruction by a barrage at B and then we may realise the dimensions of the problem of risk of avulsion involved.

AFFLUX AT BARRAGE.

The formula most commonly used in India—it is given in most text-books on hydraulics—for calculating discharge through a submerged rectangular notch—see Fig. 3—is:—

$$Q = \tfrac{2}{3} c_1 \sqrt{2g}\left((h + h_a)^{\frac{3}{2}} - h_a^{\frac{3}{2}}\right) + c_2 x \sqrt{2g}\left(h + h_a\right)^{\frac{1}{2}}$$

In the case of our barrage $Q = \dfrac{1{,}500{,}000}{3960} = 379$ cusecs, $(x) = 199 - 176 = 23$ft.

The usual values for c_1 and c_2 are respectively 0·577 and 0·8. A probable value for velocity of approach in this case is 10ft. per second, in which case $h_a = 1{\cdot}5$ft., roughly. From these data I deduce that the afflux $h = 4$ft.

Even if we suppose, as extreme possibilities, that $c_2 = 0{\cdot}9$ and $v_a = 12$ft. per second, we get $h_a = 2{\cdot}25$ft. and $h = 2{\cdot}25$ft. In an article published in *The Times Engineering Supplement*, December 5th, 1925, I put the afflux at 2·25ft. Mr. Bellasis declares that the afflux will not exceed 1ft. He gives no figures in support of his view, but naïvely surmises that I have omitted to take reckoning of the velocity of approach.

THE BACKWATER CURVE.

The Indus, according to the reports of the Indus River Commission, flows past a "string of islands from Bhakkar to Din Belo, a distance of 4660ft., with enormous velocity, in two streams which unite below Din Belo and form eddies and whirlpools which affect the discharge to a considerable distance downstream."

I have shown above that the afflux at the barrage of the maximum flood will probably be as much as 4ft., and certainly not less than 2·25ft. In the project report it is estimated that the afflux will be only 1ft., that this will diminish to "4in. or 5in." at the Outfall Station, and that it will vanish at Bhakkar, and so will not interfere with flow there. Mr. Bellasis says that this calculation is "nearly correct," although he himself estimates that the afflux will be 10½in. at the Outfall. He declares that:—"At any particular cross section in a wide channel the surface slope S is altered by heading up, so as to be nearly inversely as d^3, d being the mean depth of water."

The Indus at Bhakkar flows in two streams, the aggregate width of which is less than 1400ft. From Bhakkar to Din Belo the nature of flow is as described above. At the Outfall Station the width is 3500ft., and at Site II., three miles below Bhakkar, it is 5600ft.

Mr. Bellasis ought to know that, in reckoning the backwater curve over a three-mile length of such a river, it is not permissible to ignore the variations of cross-sectional area and of width, and to assume that the varying surface slope is dependent on the water depth d only. The slope must vary with width w as well as with d, and in the present case neither d nor w is known anywhere upstream of the outfall station.

In the report on the project Mr. Musto described the hydraulics of the Indus in the reach from Din Belo to Site II. as follows:—"The conditions of the river are so extraordinarily irregular that I have found all calculations useless. The bed slope, surface slope and coefficients are unknown and constantly changing. After many lengthy calculations I find they all lead to absurdities and consider that it is impossible to calculate conditions at a given section from any application of the theory of flow."

If Mr. Bellasis had read the project report and studied the hydraulics of the Indus at Sukkur, he would have been less complacent with his speculations about d^3 and S. He is not even aware of the existence of a gauging station at Gao Ghat, 1800ft. downstream of Din Belo, or of the peculiar hydraulic conditions prevailing there.

In a case like this, mathematical theories must be applied, if at all, with common sense. If the Indus, from Bhakkar to Site II., were of constant width and depth and gradient, an afflux of x feet at Site II. would, with the hydraulic data of high floods, produce an afflux of $\frac{1}{2}x$ at Bhakkar, 16,000ft. upstream, according to Dupuit's formula. But with the stream 5600ft. wide at Site II., and only 1400ft. wide at Bhakkar, it is commonsensical to suppose that the afflux would be greater than $\frac{1}{2}x$ at Bhakkar. This is on the supposition of clear water conditions. But in dealing with silt-laden water it is a common experience on Punjab perennial canals that the raising of a weir, or notch overfall, by x feet, causes the bed and water surface slope of the channel upstream to rise in parallel sympathy; so that the backwater curve does not materialise according to theory.

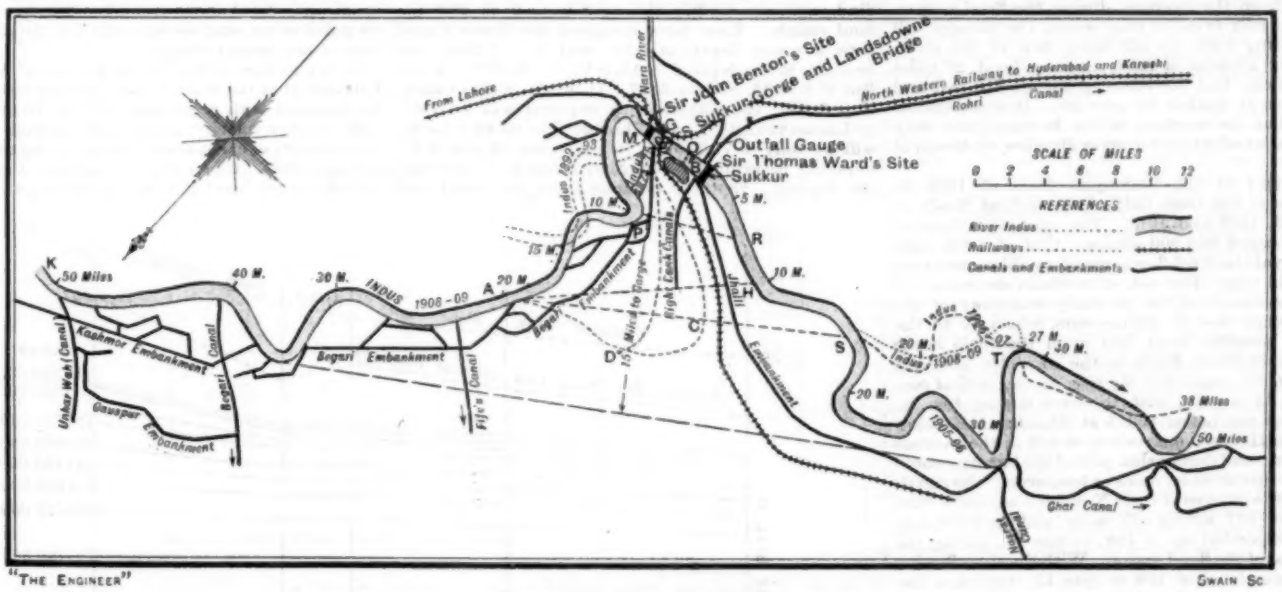


FIG. 2—THE INDUS AT SUKKUR

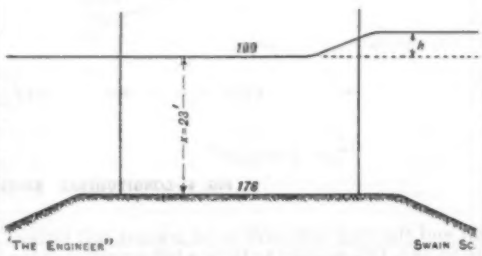


FIG. 3—MAXIMUM FLOOD AT SUKKUR BARRAGE

A STANDING WAVE FORMATION.

Table II., page 682, and Fig. 4 exhibit the water levels of the Indus for different discharges. These figures have been taken from the reports of the Indus River Commission; and for each discharge up to 720,000 cusecs each figure represents the average of data of measurement made on from six to sixteen different days in different months and years of the period 1911–1919. They differ appreciably, of course, from corresponding statistics of the period prior to 1906, as shown in Table I.

By plotting the actually observed water levels and discharges on a diagram, and drawing a curve through them, I deduce that the level of the flood of 1,500,000 will be 201 at outfall, instead of 200, as estimated in the project report, and 207 at Bhakkar, instead of 205 only. I have shown, above, that the afflux at barrage site may be up to 203, instead of 200 only. At Bhakkar it may be perhaps 210, instead of 205 only. The afflux at Bhakkar is necessarily somewhat conjectural; but it has been rationally deduced from existing data of observation, and it is the business of the engineer to design with a reasonable margin on the side of safety.

It is noticeable in Table II., page 682, that for all discharges exceeding 500,000 cusecs the fall of water surface from Din Belo to Gao Ghat, a distance of 1800ft., is a *minus* quantity, indicating "standing wave" conditions. The water surface at Din Belo "breathes" violently, with vertical gurgitations of as much as from 3in. to 5in. every two seconds. The levels recorded by the Indus Commission are those of the highest wave crests, instead of the mean level of fluctuation. If the mean level had been recorded, the figures given in Table II. would probably have shown standing wave conditions under all discharges, even down to 160,000 cusecs. An afflux of 3ft. or 4ft. at the barrage site might have the effect of damping out this standing wave at Din Belo; and if so, the consequent effect on afflux and velocity above Bhakkar might be very considerable.

The Indus River Commission has, ever since the year 1901, made hydraulic measurements of the Indus at the Sukkur Outfall Station twice a week. The fall of water surface between Din Belo and Outfall, divided by the distance between these stations, has been assumed to represent the surface slope at Outfall for the purpose of Kutter's N calculations. After eighteen years of such observations, the Commission decided that these slopes were "altogether useless for calculating the discharge coefficient or Kutter's N. The values obtained are most irregular and quite useless. These N observations have therefore been discontinued."

The standing-wave formation between Din Belo and Gao Ghat, above referred to, may help to explain the failure of the N application to such conditions.

A similar case came under my observation many years ago, when I had occasion to straighten portions of the West Jumna Canal—an old and very tortuous channel, dating from the fourteenth century—by cutting across sharp bends in its course. At one place I cut off a bend, 4 miles long, by a straight cut, only 2 miles long. The mean velocity of flow was greatly increased; the water surface levels were lowered by more than 1ft. for a long way upstream, and downstream of the cut; and at one place, about 4 miles downstream of the cut, I found the water surface

higher at the downstream end than, at the upstream end, of a 500ft. length of the canal.

Sir John Benton's Specification.

The water level of the Indus at Bhakkar was, prior to 1906, hardly ever below 192 during the flood season, June to September. Accordingly, in the project of 1912 it was specified that the gates of the barrage must not be used to pond up flow above that level, the idea being that it would be risky to check flow during the silt-carrying season. In the project of 1920 it is proposed to pond up the river at Site II. to 194·5, which corresponds to 197 at Bhakkar when the river is flowing free. That is to say, the river is to be held up about 5ft. higher than was considered safe in 1912. Statistics of the period 1907–1920 show that the Bhakkar level is below 196·5 for 100 days out of 122, on the average, during the flood season, so that for four-fifths of that season the barrage will be interfering with the silt-laden flow of the river. Prior to the avulsion of 1906, the river bend, 20 miles below Sukkur, had the effect of raising the bed and water levels at Sukkur by over 2ft. It is reasonable to infer that the working of the barrage gates may have a similar effect on the river 20 miles upstream of Sukkur.

The height of the maximum flood of 1906 at Bhakkar was less than that of the highest floods of 1897, 1903, 1905 and 1914. The maximum flood of 1914 discharged 950,000 cusecs; that of 1906, only 617,000; yet the 1906 flood caused avulsion, and that of 1914 did not. The risk of avulsion depends, not on the magnitude of the masonry waterway of the barrage, when free of silt deposits, relatively to the maximum possible flood, but upon the ratio borne by even much lesser floods to the *available waterway of the earthern channel of the river at any critical time or place*. At present, with the river flowing free, its water levels are below 196·5 at Bhakkar and below 194 at Site II. for 100 days out of 122 in the average flood season; and during that period the barrage would be holding up the river, more or less, even if the canals did not silt, and even if their N did not exceed 0·020. But if N = ·027, silting will ensue, and the river may need to be ponded up to 198, at Site II., during the greater part of the flood season. With the river flowing free, a water level of 198 at Site II. implies a discharge of more than 1,000,000 cusecs, and we know that in 1906 a flood of only 600,000 caused river avulsion. The project engineers would have avoided this difficulty if they had adhered to Sir John Benton's specification, and kept canal F.S.L. several feet lower than the controlled level of river, in accordance with Punjab perennial canal practice.

Kutter's Coefficient N for Canals.

The perennial canals of the Sukkur barrage project of 1920 are five in number. Three of them are designed to discharge from 11,000 to over 12,000 cusecs apiece, on the assumption that N = 0·020. Some recorded values of N for existing large canals are:—

Table III.

Canal.	Country	Discharge.	Water depth (*d*).	Mean velocity (V).	Kutter's (N).
East Nara	Sind ..	12,000	9·5	3·49	·0265
Fuleli	Sind ..	10,000	12·3	3·00	·0270
Lower Chenab ..	Punjab	10,500	12·2	3·40	·0285
Lower Chenab ..	Punjab	10,500	11·5	3·40	·0270
U. Bari Doab ..	Punjab	4,400	9·6	3·74	·0270
West Jumna	Punjab	2,800	4·1	2·50	·0300
Menufia	Egypt	10,000			·0275

In the light of these data it is not prudent of the Sukkur barrage engineers to ignore the possibility that the canals of their project may exhibit values of N as high as 0·027, or even higher.

The Punjab practice in designing such canals is to assume N = 0·0225, or N = 0·025, but at the same time to guard against the effect of higher values by keeping the full supply level (F.S.L.) of the canal well below the controlled level of the river. The Lower Chenab Canal was designed with N = 0·025, but its F.S.L. was kept 4ft. below the controlled water level of the river, and in practice the F.S.L. rose, through silting, just about 4ft. higher than originally designed.

In the Sukkur barrage project of 1912 it was assumed that N = 0·020 in the case of the Rohri Canal; but at the same time, as a precaution in case of silting, it was specified that canal F.S.L. should be 1·5ft. lower than the lowest river level (192) of the flood season. This left a margin of 6·5ft. between canal F.S.L. and the normal level of the river in August (197·0). With the river flowing free, 192 at Bhakkar corresponds to 190·5 at Barrage Site II., but the project of 1920 fixes canal F.S.L. at 193 instead of 189 at Site II.

If the canal, in practice, shows N = 0·027, its F.S.L. will rise to 195, even when the water is free of silt, and the river will have to be ponded up to 195·5 in order to feed it.

Table II.

Discharge, cusecs.	Water surface levels.				Fall of water surface.			
	Bhakkar.	Din Belo.	Gao Ghat.	Outfall.	Bhakkar to Din Belo.	D. Belo to G. Ghat.	G. Ghat to Outfall.	Bhakkar to Outfall.
160,000	190·92	190·56	190·51	190·16	·36	·05	·35	·76
240,000	192·70	192·08	191·95	191·65	·62	·13	·30	1·05
320,000	193·80	193·06	193·00	192·67	·70	·06	·52	1·28
400,000	195·27	194·39	194·31	193·95	·90	·08	·48	1·46
440,000	196·59	195·51	195·31	194·78	1·08	·20	·53	1·81
520,000	197·00	195·84	196·24	195·31	1·16	—·40	·93	1·69
600,000	197·90	196·34	196·44	195·83	1·56	—·10	·61	2·07
720,000	199·44	197·47	197·44	196·80	2·00	·03	·64	2·67
800,000	200·24	197·84	198·14	197·13	2·40	—·30	1·01	3·11
880,000	201·74	198·84	199·14	198·23	2·90	—·30	·91	3·51
949,000	201·44	198·54	198·84	197·83	2·90	—·30	1·01	3·61
Probable 1,500,000	207·0	201·7	202·6	201·0	5·30	—·90	1·60	6·00

Kennedy's formula for the least velocity necessary to prevent deposit of silt is $V_o = 0·84\ d^{0·64}$. The Sind engineers modify this to $S\,V_o = 0·63\ d^{0·64}$ for Sind canals. They have designed the Rohri Canal with a water depth of 13ft. and V = 3·26ft. per second. When depth $d = 13$, $S\,V_o = ·63\ d^{·64} = 3·26$. But if $d = 15$, $S\,V_o = 3·57$. If, in the Rohri Canal, N = 0·027, the water depth required will be 15ft. and mean velocity V = 2·71 only. The mean velocity will be only 2·71/3·57 = 76 per cent. of the $S\,V_o$ required according to the Sind formula, to prevent silt deposit. In these circumstances the canal will silt and the river will have to be ponded still higher, up to, say, 197, in order to force a full supply over the shoal.

The Central (right bank) Canal has been designed with N = 0·020, *d* = 12·75, V = 3·25, and F.S.L. = 194. But if N = 0·027, *d* = 15, V = 2·76, and F.S.L. becomes 196·25, even when the water is clear. Also, if *d* = 15, $V_o = 3·57$. The mean velocity will be only $\frac{2·76}{3·57} = 77$ per cent. of that required to prevent silt deposit. The canal will silt, and the river will have to be ponded up to, say, 198, to force a full supply over the silt.

So, also, in the cases of the other canals, if N = 0·027, silting will ensue, and the river may need to be ponded up to 197 or 198 at Site II. during the greater part of the flood season. With the river flowing free, as at present, nothing less than a flood of 1,200,000 cusecs would attain to those levels. The barrage, in holding up the ordinary floods, of 300,000 to 400,000 cusecs, to those levels, will be silting up the river channels to suit; so that when the big flood comes down it may find the channels too small to hold it, *and then anything may happen*.

The Left Bank Canals Need No Barrage.

The longitudinal section of the Rohri Canal in the project of 1920 is shown in Fig. 5, from its head down to reduced distance (R.D.) 324.000ft., at which point there is to be a barrage across the canal to regulate its flow. At this point the full supply level of the canal is designed to be 156·4 and bed level 143·7. The designed gradient is to be 1 in 15,600, and the water surface, shown in fine broken lines, shows that the excess of declivity is to be taken up by no less than six masonry falls, with an aggregate vertical drop of 16ft. If, however, the bed and water surface gradients were drawn upstreamwards from R.D. 324,000 at 1 in 15,600, as marked in Fig. 5 by lines of large dots, the full supply level required at head would be only 177·2, instead of 193 as designed. The water levels of the Indus are at their lowest in January and February, and the lowest monthly level ever recorded at Site II. has been 182·3, which is fully 5ft. higher than the full supply water level (177·2) required for the Rohri Canal in the summer and 8ft. or 9ft. higher than its winter water level. Thus there is no need for a barrage across the Indus to hold up its flow for the canal. A noteworthy feature in the case is that the Rohri Canal is designed to do no irrigation till it has passed through the Khairpur State and emerged into British territory at the point marked X, Fig. 1, R.D. 248,000, so that there is no necessity to keep the canal water level above ground surface level in its first 50 miles or so, and no necessity for the six masonry falls of the project design.

In my lecture at the Royal Society of Arts in 1922 I showed that the Rohri Canal (without barrage) could be designed with a gradient of 1 in 10,000, so as to give a higher velocity, greater silt-carrying power, and less quantity of excavation, besides saving the cost of six masonry falls. Under these conditions I showed that its full supply level at head would be no higher than 186·0, in summer and no higher than 181·0 in winter. Deficient familiarity with perennial canal science has led Mr. Bellasis to follow the Gusto Note in the error of supposing that the winter water level of a canal is necessarily the same as its summer full supply level.

He errs also in supposing that the canal head (without barrage) of my design must necessarily be situated at Site II. I definitely said that it might be anywhere in the three-mile stretch of gorge between Site I. and Site II. for the left bank canals. The minimum waterfall into these canals (anything from 1ft. in the case of a 1 in 10,000 gradient, to 8ft. in the case of a 1 in 15,600 gradient) would ensure its securing perennial flow.

The East Nara Canal is to begin irrigating at its 105th mile (marked W in Fig. 1), where its water level is designed to be 104, or 78ft. lower than the

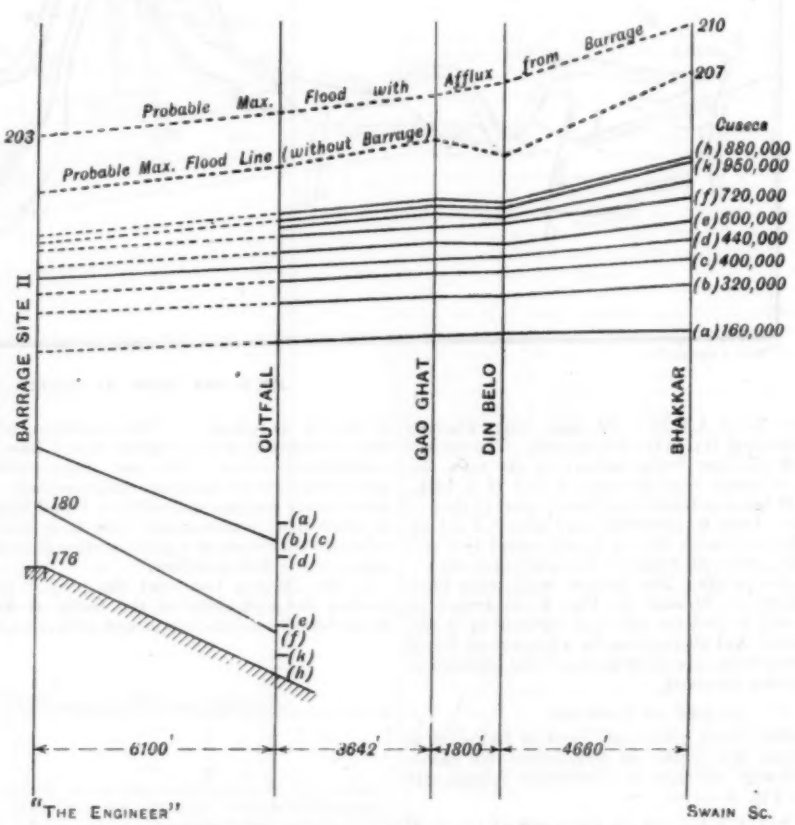


FIG. 4—LONGITUDINAL SECTION OF INDUS AT SUKKUR

lowest water level of the Indus at Sukkur. The canal would need a fall of only from 35ft. to 52ft. in that distance, according as it were graded at 1 in 10,560 or 1 in 15,640. There is no sense, therefore, in holding up its F.S.L. at head 194·2 by means of a barrage, as has been arranged in the project design.

THE RIGHT BANK CANALS.

The Bombay Government reluctantly admitted, in 1915, that a barrage was not essential for the service of the canals on the left bank of the Indus, but it still considered that it was necessary for the canals on "the higher ground on the right bank." When the engineers, however, were preparing the 1920 project they could not find any ground high enough to justify a barrage, except by carrying their canals across the West Nara Valley (shown in a line of arrow heads in Fig. 1) and up the reverse slope beyond, at the foot of the mountains of Baluchistan, in order to irrigate the strips of land marked by hachures on the map. Even this they could only achieve by designing the barrage to pond up the river to 194·5 at Site II. and by fixing canal F.S.L. at 194·0 or 193·5. Having no personal experience of the working of perennial canals, they overlooked the practical working rule, determined by Punjab experience, that a larger margin must be allowed between canal F.S.L. and controlled water level of the river in order to allow for the contingency of silt deposits, and for the vagaries of Kutter's N. They are now on the horns of a dilemma. Either they must lower canal F.S.L. by 4ft., and abandon the scheme for irrigating beyond the West Nara; or else they must hold up the river perilously high, and face the risk of avulsion. They could have avoided this difficulty by placing the barrage at the point marked N in Fig. 1; a point which is just as close to the trifurcation T of the right bank canals as Site II., whilst its water levels are 10ft. higher. A barrage at N, or at D, or at K, would not need to pond up the flow of the river at all during the flood season.

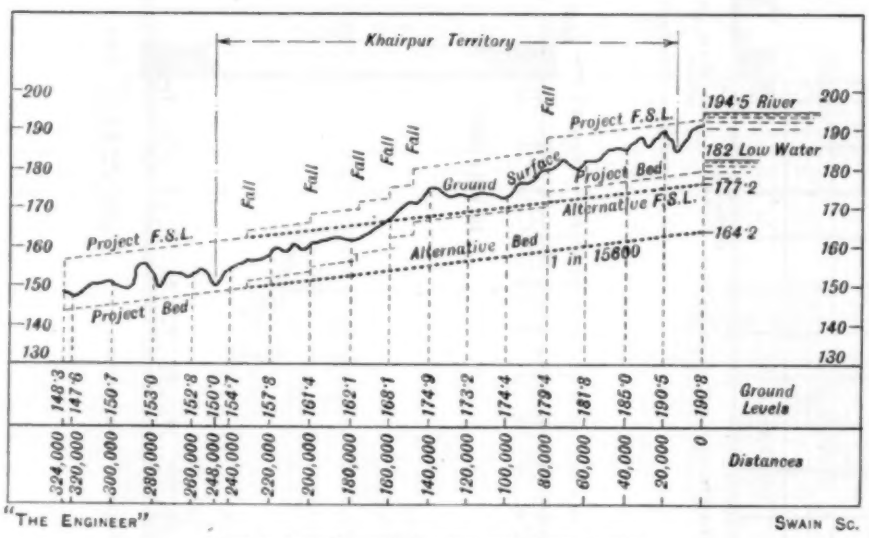


FIG. 5—LONGITUDINAL SECTION OF ROHRI CANAL

The fact is that Sukkur (Site II.) is *a good site for canals without barrage*, to irrigate to the left of the Indus downstream of Khairpur territory, but it has no special merits as a site for a barrage.

Sir John Ottley, President of the London Committee of 1913, wrote: "I find, throughout the old correspondence, constant references to 'stable' points of the river, as being the only points at which it was possible to take off canals with any certainty of maintenance of their heads. This is, of course, absolutely true in the case of 'inundation canals,' but . . . the construction of a weir or barrage with sufficient guide banks, enables the engineer to make *any* point stable."

For the service of *perennial canal heads, without barrage*, stability of location can be secured in the same way as is adopted in the modern science of railway-bridge building. A masonry floor or weir carried right across the river is not at all essential.

In an article which appeared in *The Times Engineering Supplement* of August 15th, 1925, I showed that if a canal, without barrage, were offtaken from the river at Kashmor, where it enters the province of Sind—marked K in Fig. 1—and conducted from thence to the point A, it would be able to deliver water to the trans-West Nara tract at a level 23ft. higher than the N.W. canal of the 1920 project, and would be able to increase the irrigable area by a million acres. Mr. Bellasis declares that the river has no stable channel at K. But a reference to Fig. 1 shows that the river there has on its right flank a spur of the Baluch Mountains, which effectively prevents any avulsion of the river to the right. And since Mr. Bellasis contends elsewhere that the Indus has a peculiar tendency to work its way to the west, or right, he cannot escape from the conclusion that the site K is practically stable. At Sukkur the river is liable to change its course either to left or right, and to abandon the Sukkur gorge; but at Kashmor it is fixed as to its right bank, so that only the left bank need be looked after there.

If an avulsion to the left occurred above Kashmor, it would affect Sukkur just as well as Kashmor.

Mr. Bellasis' professional experience has been connected chiefly with the primitive Inundation Canals of the Punjab, the silted beds of which are, in the low-water season, above the low-water levels of the parent rivers. The case of the weirless perennial canals, which I have advocated, is very different. Their F.S.L. will be several feet lower than the lowest water levels of the parent river, and natural gravitation will assure them of a constant perennial flow.

CONCLUSION.

The Asyut barrage, in Egypt, works with a maximum afflux of 8ft. The afflux in the design of the Sukkur barrage has been limited to 1ft., through fear that a greater afflux might cause river avulsion. In consequence of this limitation of afflux the waterway has been designed nearly 4000ft. wide, and the cost estimated at £4,000,000. *It is only the proximity of the narrow gorge to the barrage site II. which dictates that limitation of afflux.* If the barrage were built anywhere, more than, say, 20 miles up stream of Sukkur, it could be designed for a much higher afflux at half that width of waterway and cost. The project of 1920 aims at increasing the annually irrigated area by 3,300,000 acres at a cost of £12,000,000, or £4 per acre. If the barrage were built 20 miles or more upstream of Sukkur, to a width of 2000ft. or less, it could increase the annually irrigated area by another million acres, or more, at a cost of about £2 10s. per acre over all. And in this case it would not be necessary to pond up the flow of the river at all in the flood season. Alternatively, if the barrage were omitted altogether, canals offtaking from Kashmor—K—right bank, and Sukkur, left bank, could do all the irrigation possible under the project of 1920, at £4,000,000 less cost. The Egyptian Government is about to build on the Nile, at Nag Hamadi, a barrage estimated to cost £2,000,000 only. The taxpayer of Sind will have to pay double that figure for his barrage, if the design of 1920 be carried out.

The average monthly water levels of the flood season of the Indus at Bhakkar since the year 1850 are tabulated below by ten-year periods. Those of the decade 1901–10 have been split up to show the effects of the avulsion of 1906, whilst those of the "dry" cycle, 1898–1902, have been shown separately, in contrast with those of the "wet" cycle 1903–05.

TABLE IV.

Period.	Average water levels at Bhakkar.				
	June.	July.	August.	September	Averages.
1851–60	192·5	194·9	195·8	192·1	193·8
1861–70	193·8	195·6	196·2	193·3	194·7
1871–80	195·1	197·1	198·2	194·6	196·3
1881–90	195·2	197·4	198·5	194·5	196·4
1891–00	194·3	196·7	197·9	194·2	195·8
1901–05	195·6	197·6	198·3	195·2	196·7
Averages	194·4	196·6	197·5	194·0	195·6
1907–10	193·4	195·3	197·6	194·4	195·2
1911–19	193·8	195·0	196·4	192·8	194·5
Averages	193·6	195·2	197·0	193·6	194·9
1898–02	194·2	196·1	196·8	194·6	195·4
1903–05	196·4	197·5	199·1	195·5	197·1

The idea of building a barrage originated in the low water levels of the period 1898–1902, which were, however, much higher than those of the twenty years 1850–70. After being smothered by the investigations of the engineers, the idea smouldered for a time; but the low water levels, following upon the avulsion of 1906, resuscitated the idea, which was blown into flame by Sir Henry S. Lawrence, under the influence of the disastrous year, 1918, of war, famine and pestilence (influenza). The water levels of 1918, however, were not so low as those of the year 1855. The Bombay Government is still opposing all fresh irrigation enterprises of the Punjab Government, under the impression that the latter have lowered the water levels of the Indus at Sukkur. The statistics tabulated show, however, that these water levels were lower during the period 1851–60, *when there were no perennial canals in the Punjab*, than they have ever been since.

The figures suggest that a river avulsion, similar to that of 1906, occurred shortly before the year 1850. Such avulsions may, perhaps, do no very great harm in some cases. An avulsion from the Sukkur bend, however, would ruin the towns of Sukkur and Rohri, besides spilling to waste the vast sums of money spent in that vicinity. That is why it is more objectionable to build near Sukkur, than elsewhere, a barrage which may increase any existing risk of avulsion in that locality.

A New Elbe Railway Bridge.

THOSE of our readers who have chanced to travel on the main line to Berlin within the last two years will have noted the work which has been proceeding on a new double track railway bridge spanning the river Elbe, at Hämerten, near Stendal. The bridge, which was recently completed, is built on the upstream side of the old bridge, and runs parallel to it at a distance of about 21 m. The old bridge, which is also a double-track bridge, was finished in 1870, and, like the new one, it has eighteen spans with an approximate total length of 808 m., or about 2650ft. In order to meet the increasing demands of heavier traffic, the old bridge has had to be strengthened on more than one occasion since 1894, when an original swinging span was made into a fixed structure.

In 1922 the German State Railways decided to construct the new bridge, which has been designed to meet the requirements of the heaviest locomotives and rolling stock. A maximum weight of 25 tons on each locomotive driving wheel has been provided for, which may be expressed as 13·67 tons per metre run of rail, an allowance of 8 tons per metre run being made for rolling stock. The new structure has been built under two separate contracts. Nine of the largest spans are over the main bed of the river, while a further nine low spans bridge the flat and often flooded land on the west bank. The last mentioned section of the bridge was begun in 1924, and was built by Louis Eilers, of Hannover-Herrenhausen. The part over the main stream was, however, entrusted to the firm of Friedrich Krupp, A.G., the actual work being carried out by the Friedrich-Alfred-Hütte, of Rheinhausen. Work on that section was begun in August, 1925, and the three first spans on the left bank, Nos. 1 to 3, were first built, followed by span No. 4. Operations were then started on the three spans 9, 8, and 7, abutting the previously existing nine low spans on the west side. The span No. 6 was then placed in position, which allowed the closing, and incidentally the largest, span, No. 5, to be built out from spans Nos. 4 and 6, which formed the crane anchorages. The closing members of the final span were made to template, and the bridge was finished in August last.

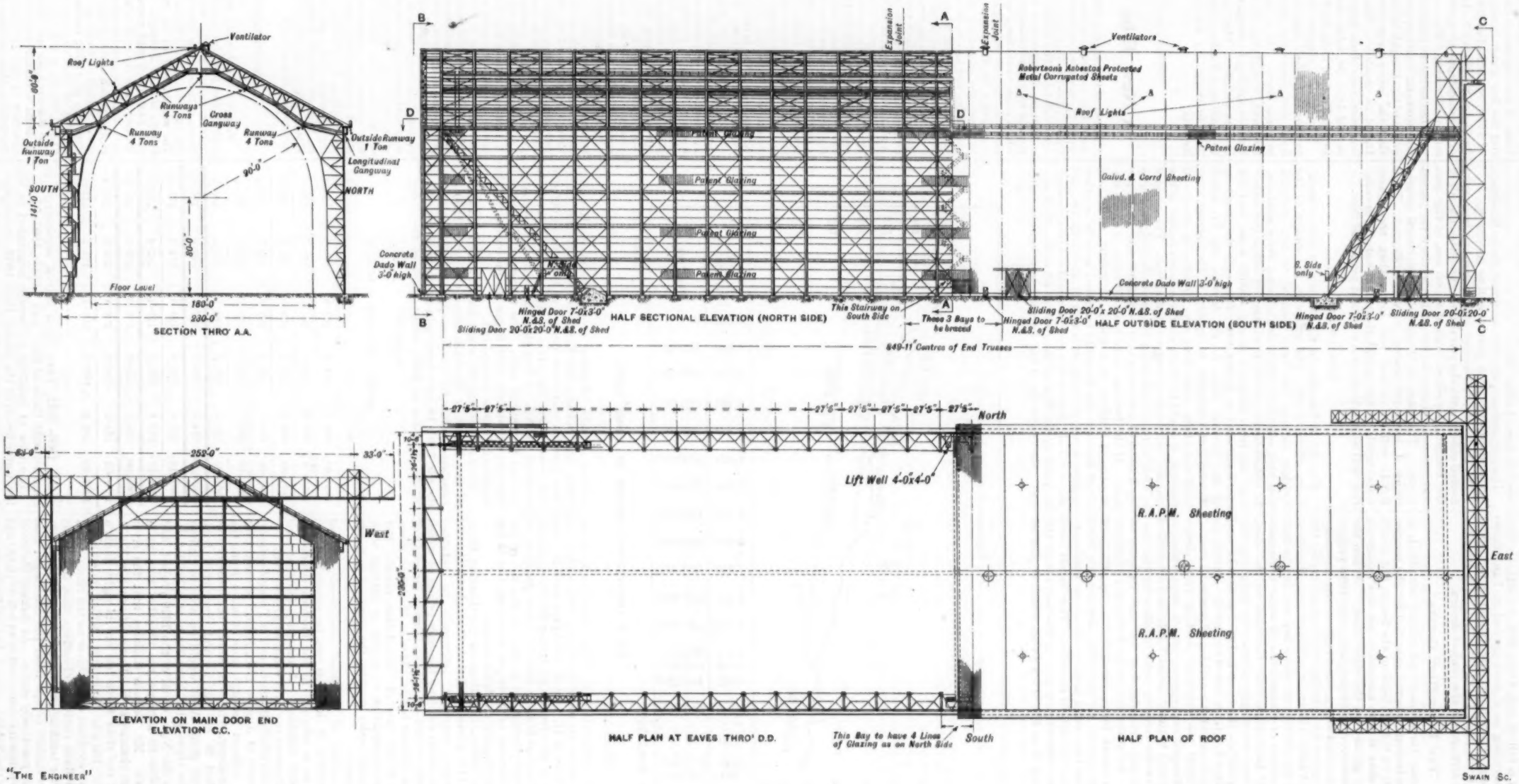
It is of the overhead trussed girder type, and No. 5, the largest span, has a length of 106 m., while the maximum girder system height is 15 m. Spans Nos. 4 and 6 each have a length of 67 m., with a height of 9 m., while the two groups of three spans, Nos. 1 to 3 and 7 to 9, are 40·56 m. and 45·01 m. long respectively, with a height of 5·5 m. The main girders of the bridge are spaced 9 m. apart, with 3·5 m. between the centres of the two rail tracks. A footway, with a width of 1·4 m., is built at one side of the bridge. All main girders and bracings are made of steel No. 48 of the German State Railway Standards of 1924. This material has a breaking strength of 45–58 kilos. per square millimetre, a yield point of 29 kilos. per square millimetre, with an elongation of 18 per cent. on a 200 mm. gauge length. In the bending test the material, in strip form of 30 mm. to 50 mm. wide, was bent cold over a mandrel of a diameter twice the thickness of the test plate. With the ends of the test bar at an angle of 180 deg., there was no sign of cracking. For the footway girders and supports and some secondary members No. 37 standard steel was employed. A full account of the building of the bridge, together with a number of working drawings and a progress plan, is given in an article by Director Oswald Erlinghagen, of the Friedrich-Alfred-Hütte, which appears in the November number of the *Kruppsche Monatshefte*.

THE construction of a number of new branches, forming part of the plan for general extensions of the provincial railway systems, will shortly begin in the province of Buenos Aires. The first work will be a prolongation of the line from Azul to Bahia Blanca, and thence to La Prida. The second will be an extension of the La Plata–Mira Pampa line to Bohuajo. This portion of the work will cost 23,633,000 gold pesos (5·04 gold pesos = £1). The Buenos Aires Great Southern Railway will proceed forthwith with the construction of a branch line from Dolores to Ajo, which takes the place of a project for a narrow-gauge line. Simultaneously a wide programme of road construction providing feeders for the railway will be commenced in this district, the outlay being estimated at 31,500,000 paper pesos (2·27 paper pesos = 1 gold peso). The Buenos Aires and Pacific Railway has been authorised to build a branch from La Bouleye in a north-westerly direction to join up with the branch from Mackenna to Sampacho, thus linking a number of rich agricultural districts hitherto lacking transport facilities.

THE AIRSHIP SHED AT KARACHI, INDIA

THE ARMSTRONG CONSTRUCTION COMPANY, LTD., LONDON, ENGINEERS

(*For description see opposite page*)



"THE ENGINEER"

SWAIN Sc.

The Karachi Airship Shed.

WHEN the British Government in 1924 decided to proceed with the construction of two large airships, each of 5,000,000 cubic feet capacity, it became necessary to consider the provision of suitable ground works to render the operation of the airships possible. These ground works, entailing an expenditure of about £500,000, were settled upon as follows:—

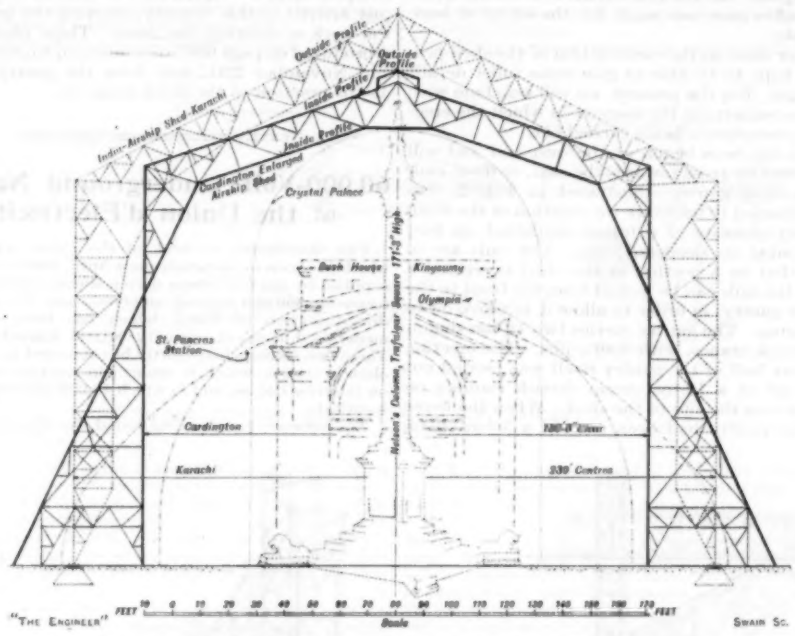
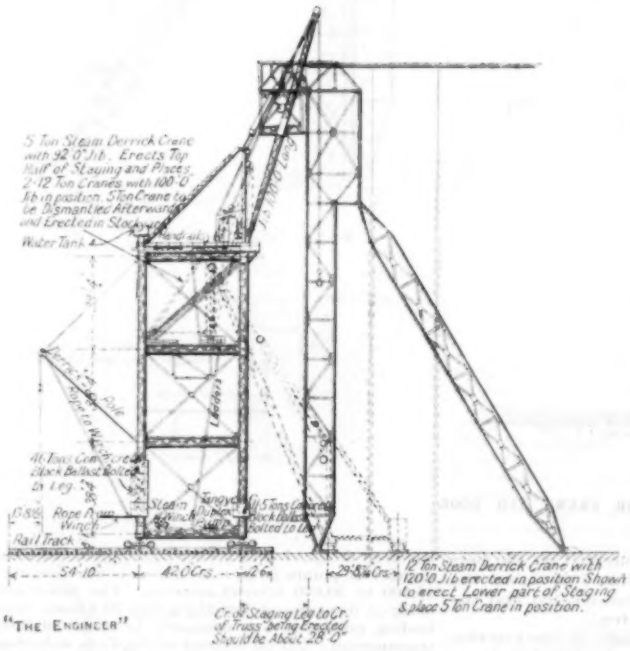


FIG. 1—COMPARISON BETWEEN THE KARACHI AND CARDINGTON SHEDS

have mentioned, the Karachi shed is not yet completed. But at the moment of writing, the erection gantry has been finished, and progress with the assembly of the shed should now be rapid.

In Fig. 1 we give a diagram comparing the cross-sections of the Karachi and Cardington sheds with each other, and with certain well-known structures in the London area. It will be observed that the Crystal Palace could just be housed beneath the roof of the Cardington shed, and that Nelson's Column could be comfortably accommodated within


5 Ton Steam Derrick Crane with 92'0" Jib. Erects Top Half of Staging and Pieces. 2-12 Ton Cranes with 100'0" Jib in position. 5 Ton Crane to be Dismantled Afterwards and Erected in Stock
Water Tank
40 Tons Concrete Block Ballast Bolted to Leg
Steam Winch
Tangye Pumping Unit
10 Tons Concrete Block Ballast Bolted to Leg
Rail Track
54'10"
42'0 Crs.
29'8½ Crs.
12 Ton Steam Derrick Crane with 120'0 Jib erected in position Shown to erect Lower part of Staging & place 5 Ton Crane in position.
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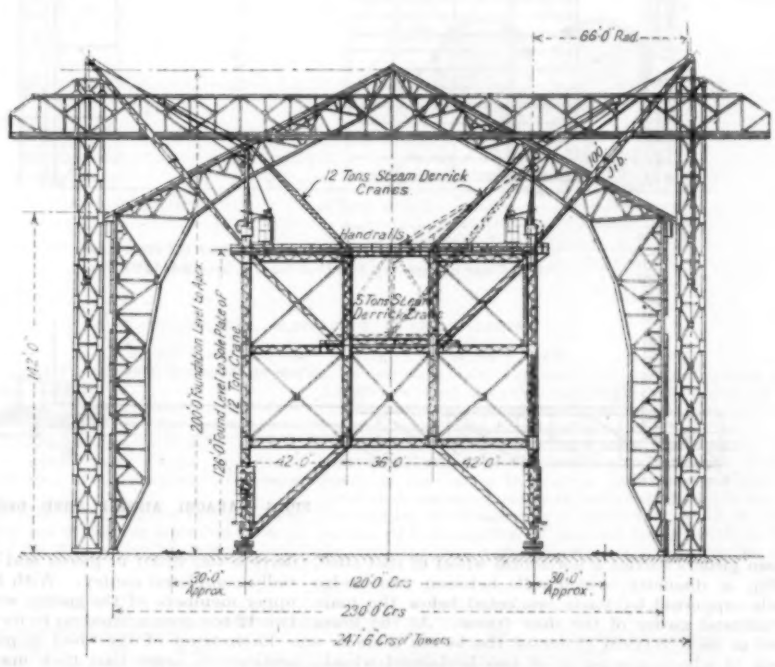
Cr of Staging Leg to Cr of Truss being Erected Should be About 28'0"



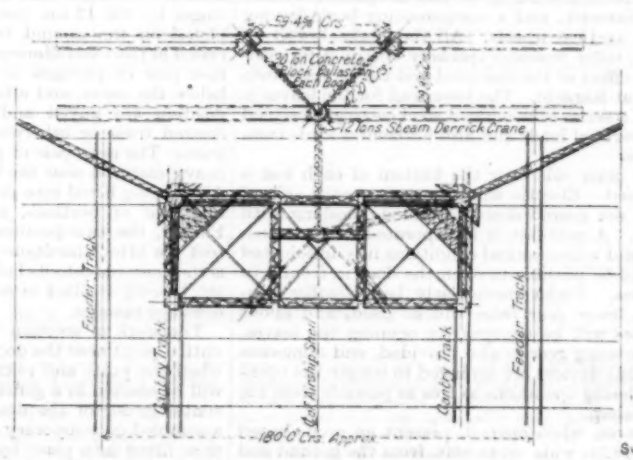


FIG. 2—ERECTION GANTRY AND END TRUSS

At Cardington, near Bedford, the existing airship shed built for the Admiralty in 1916–17 was to be enlarged by adding 112ft. to its length and 35ft. to its height; thereby giving it a clear height at the centre of about 156ft. 8in., a length of 812ft., and a clear width at the floor level of 181ft. 6in.—unaltered. A mooring tower and other incidental works were also to be erected at Cardington. All these works have now been completed. At Ismailia, Egypt, a mooring tower was to be erected and a hydrogen-producing plant constructed. The hydrogen plant at this station works on the "Silicol" system, and is rated to produce 1,000,000 cubic feet per day. It has, we understand, now been completed. At Karachi, India, a new airship station was to be formed, the equipment including an airship shed and a mooring tower. It is the purpose of this article to give a preliminary account of the design and method of erection of the Karachi shed, the largest structure of its kind in the British Empire and one of the largest single buildings in the world.

The contract for the Karachi shed was given to the Armstrong Construction Company, Ltd., of London, a subsidiary organisation of Armstrong, Whitworth and Co., Ltd., and is being carried out under the direction of the Director of Works and Buildings, Air Ministry. Unlike the other ground works we have mentioned, the Karachi shed is not yet completed. We are indebted to the "Journal" of the Royal Engineers' Institute, Chatham, for the original from which this engraving was reproduced.

The site of the Karachi shed is in the desert, about 13 miles east of the town of Karachi. It lies close to an existing military and civil aeroplane station and adjoins the railway between Karachi and Malir, and also a main road running eastwards. The shed when finished will have a length of 850ft., a clear width inside of about 200ft.—180ft. at the doors—and a clear height at the centre of 170ft. It is provided with sliding doors at the east end and with a blank wall at the west end. One of the conditions of the tender was that the shed should be capable of being taken down if necessary and erected elsewhere. This requirement has been met by restricting the pieces to be assembled to a maximum weight of 12 tons, and the employment of turned bolts for uniting the pieces.

The construction throughout is of steel. The sides are covered with galvanised sheeting, and the roof with Robertson's asbestos protected metal sheets. On the north side four lines of Mellowes' patented glazing, each 8ft. deep, extend the full length of the shed, while on the south side there is one such line. Numerous gangways, runways, access staircases and so forth are provided, and down one side workshops are arranged. Lighting, power, water supply and other services are covered in the contract.

At the west end the blank wall is supported by a main horizontal girder at the level of the eaves. This girder, as shown in the general arrangement drawing reproduced on page 684, is itself supported at each end by a post and a raking strut. The struts are designed to pass through the trusses of the shed without actually touching them. The trusses, as indicated in Figs. 1 and 2, are of the three-hinged type with hinges 1ft. above the ground level, and at the ridge 200ft. above the ground. The trusses are situated at about 27ft. 5in. centres apart, and have an overall span of 230ft. In their construction considerable simplification has been achieved by making all the chord members of pairs of 15in. by 4in. channels specially rolled to various thickness as required by the stresses to be borne. This plan avoids the complication of building up the sections by the addition of plates and angles. The internal web framing consists of pairs of channels or angles, as in ordinary bridge construction, laced together with battens.

Except for its size, the construction of the shed is

on lines similar to those followed in earlier sheds. An exception to this general remark is, however, to be found in the design of the doors at the east end, which, together with their method of operation, are different from any adopted previously in British practice. The door frame is entirely separate from the shed, except for a connecting tongue near the ridge of the roof. This tongue can slide parallel with the centre line of the shed, but resists transverse movements between the shed and the door frame. Relative longitudinal movements produced by thermal expansion or wind pressure are in this way allowed for, while at the same time the doors are maintained transversely in their correct closing position.

The door frame, as shown in Fig. 3, comprises two vertical posts situated outside the shed and supported by two raking struts hinged to the posts at their upper ends. Each post has a cantilevered top from which is hung a four-sided girder, 20ft. wide by 15ft. deep. This girder is 314ft. 6in. long, and measures 247ft. 6in. between the pins by which it is suspended. The weight of the girder is borne entirely by the pins. From the lower chord a link connects the girder to each vertical post. These links carry practically the whole of the horizontal wind pressure load on the door.

The door is made in two leaves, each consisting of a steel-framed structure, 171ft. high by 91ft. wide, so designed as to concentrate all the loads on two main vertical girders. The upper end of each of these main girders carries a horizontal wheel of cast steel, 40in. in diameter, which rolls between two bridge rails supported by joists bracketed below the main horizontal girder of the door frame. At the lower end of each vertical girder of the leaves there is a nest of wheels consisting of two horizontal wheels, 50in. in diameter, and a compensating bogie having two 40in. vertical wheels. All these wheels run on Hoffmann roller bearings specially designed to withstand the effect of the fine sand and the strong winds met with at Karachi. The lower rail for the leaves is formed of a series of machined steel castings designed to carry vertical loads and also horizontal loads from either side.

On the inner side near the bottom of each leaf a rack is fixed. Electric winches, one on each side of the shed, are geared down to pinions meshing with the racks. A gear-box is incorporated in the transmission, and under normal conditions it is anticipated that it will be possible to open the door in from 8 to 10 minutes. Under particularly bad weather conditions a lower gear ratio will be used, and about 30 minutes will be occupied in opening the leaves. Hand operating gear is also provided, and numerous independent devices are arranged to render the opening and closing operations as free as possible from the risk of mishap.

The leaves, when opened, present an arch-shaped opening, 182ft. wide up to 80ft. from the ground and semi-circular at the top, the highest point of which is 171ft. above the ground level. A channel-shaped apron round the perimeter of the leaves closes against a similar apron on the shed end, and provides protection against the weather without restricting the longitudinal movement of the shed relatively to the door frame.

The foundations are designed for a maximum pressure on the ground of 2 tons per square foot. The soil at the site consists of 2ft. of sandy earth overlying 2ft. of compact fine gravel and morum lying on top of compact morum. Morum is a hard alluvial deposit. In the calculation of the foundation pressures allowance was made for the effect of horizontal loads.

At a later date, as the construction of the shed proceeds, we hope to be able to give some fuller details of its design. For the present, we will conclude with some notes concerning the manner in which the erection of the members is being carried out.

Erection has been begun at the west end and will proceed truss by truss towards the east, or door, end. A special steel gantry—illustrated in Fig. 3—has been constructed to facilitate the erection of the shed. This gantry consists of a frame supported on four bogies running on sleepered rails. The rails are so arranged that as a portion of the shed is erected a section of the rails can be moved from the front to the rear of the gantry, in order to allow it to move on to the next truss. The gantry carries two 12-ton steam-driven derrick cranes, with 100ft. jibs. The erection of the lower half of the gantry itself was carried out with the aid of a 12-ton steam derrick running on rails laid across the site of the shed. When the lower part of the gantry had been erected a 5-ton steam derrick was lifted in pieces and erected on the partially completed gantry. With this 5-ton crane the upper members of the gantry were erected and the two 12-ton cranes lifted on to its top.

Each truss of the shed is made in six erection sections, in order that they may be lifted in three stages by the 12-ton cranes. The sections are completed on the ground before being lifted, and are raised in pairs simultaneously by the two cranes. The first pair of portions of the truss are jointed just below the eaves, and after they have been placed in position are guyed and stayed to the previously erected truss or otherwise in the case of the first truss. The next pair of portions lifted consist of the heavy material near the eaves and part of the rafter. After being lifted into position they are fixed to the first pair of portions, and are guyed and stayed. Finally, the two portions forming the ridge of the roof are lifted simultaneously. The pin at the ridge is then entered into its holes, the joints are completed, the bracing is filled in and the purlins added in the ordinary manner.

The work of erection will proceed in this manner until a point near the door end of the shed is reached, when the posts and raking struts of the door frame will be erected in a generally similar way. The horizontal girder of the door frame will be completely assembled on temporary supports on the ground, and then lifted into place by means of two steel cables, blocks and tackle and electric winches. The framing for the leaves will be erected beneath the horizontal girder. Adjustment of the leaves will be made before the rollers are finally fixed, and the door frame foundation bases grouted up. As the erection of the main framing of the shed progresses independent squads of erectors working from temporary scaffolding will fill in the purlins, sheeting, glazing and subsidiary steel work.

At the moment of going to press we have received two photographs—R.A.F. Official Crown Copyright—just arrived in this country, showing the progress of the work of erecting the shed. These photographs, reproduced on page 690, were taken on November 26th and November 29th, and show the gantry at work on the erection of the third main rib.

60,000-Volt Underground Network of the Union d'Electricité.*

The distribution network of the Union d'Electricité, which has been in operation since April, 1922, is at present supplied by the new steam-driven station of Gennevilliers (capacity 360,000 kilovolt-ampères), and the old steam-driven station of Vitry, which has been completely modernised (present capacity 80,000 kilovolt-ampères). These two stations will shortly be connected to the hydro-electric station which is under construction at Eguzon, on the river Creuse, and in which 40,000 kilowatts is being installed.

The network forms a ring round the city of Paris and has been designed with a view to supplying at a limited number of points large amounts of power ranging from 15,000 to 50,000 kilovolt-ampères. The power stations being at distances of something like 30 kilomes. from the feeding points, it was necessary to adopt high-tension transmission; but on account of the Paris suburban districts through which the transmission passes being entirely built over, the use of overhead lines was out of the question, so that the power company had to adopt the highest voltage possible with underground cables. The voltage chosen was 60,000, the frequency being 50. It should be borne in mind that at the time when this voltage was selected it was everywhere considered by engineers to be extremely high, and it was only adopted after very careful laboratory researches extending over a period of two years.

The network has been in operation for over three years and at present comprises 220 kilomes. of three-phase feeders (equivalent to 660 kilomes. of single cables) and more than 2500 junction boxes. In winter nearly 2 million kilowatt-hours are transmitted daily under conditions which are now quite satisfactory from the point of view of reliability.

Reasons for the Choice of Single Cables.

At the time when it was decided to lay the first feeders three-core cables with equipotential surfaces (the advantages and disadvantages of which as compared with single cables will be discussed later) were not available. The company had therefore to choose between armoured three-core cables of the ordinary type and lead-sheathed single cables. After a series of tests, which in themselves proved of great interest, the idea of using three-core cables was abandoned because they did not provide a sufficient margin of safety or an adequate overload capacity. The reasons were as follows:—

(*a*) The electric field in a three-core cable being rotary,

* Abstract of paper read before the Institution of Electrical Engineers by Colonel E. Mercier. December 16th.

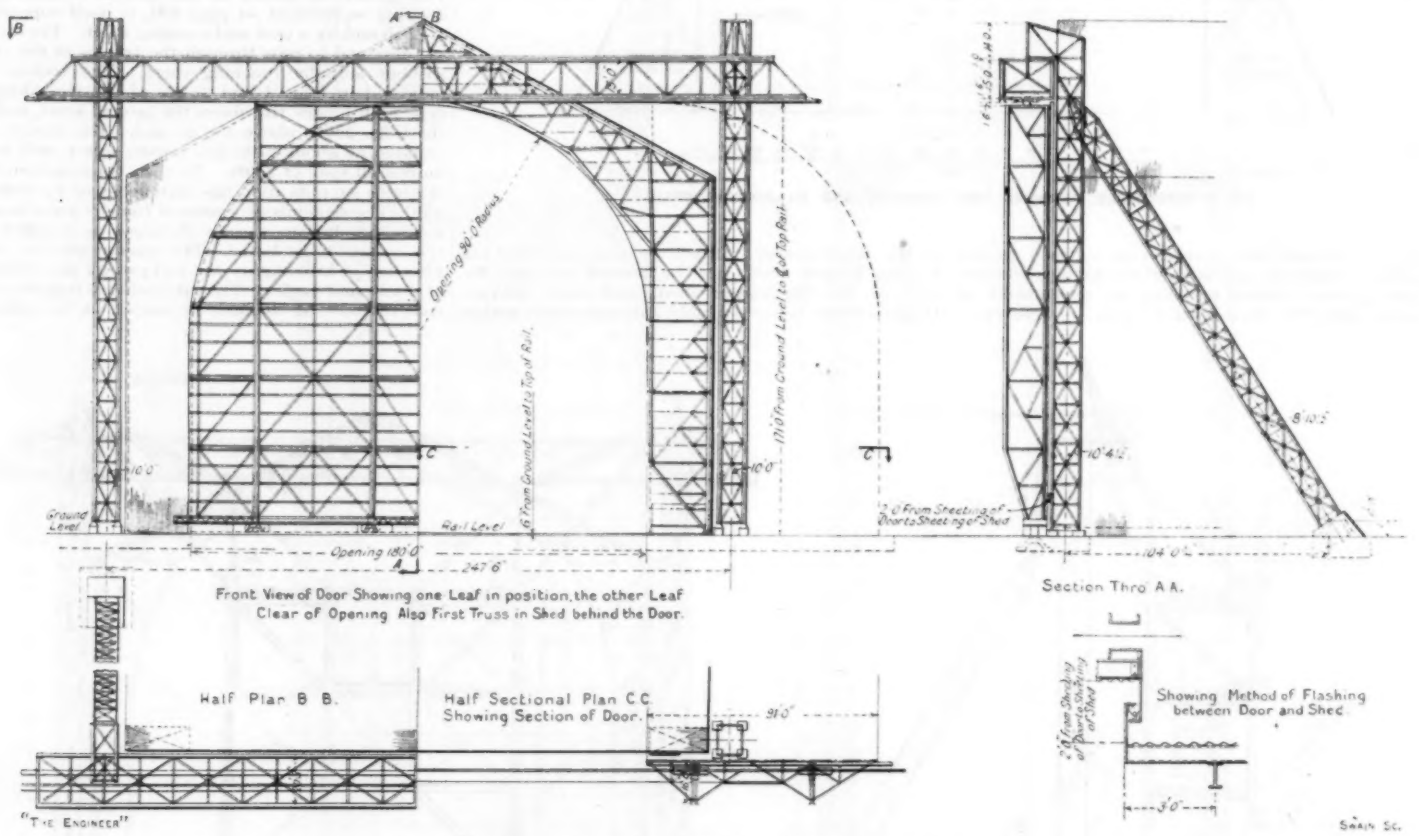

Opening 180'0"
247'6"
Front View of Door Showing one Leaf in position, the other Leaf Clear of Opening Also First Truss in Shed behind the Door.
Half Plan B B.
Half Sectional Plan C C Showing Section of Door.
Section Thro' A A.
Showing Method of Flashing between Door and Shed.
"The Engineer"
Sabin Sc.

FIG. 3—KARACHI AIRSHIP SHED—DOOR FRAME AND DOOR

at certain instants the electric lines of force are tangential or parallel to the layers of the paper insulation, and it can be conceived that the lengths of their paths through any bubbles of air which may be occluded between the layers of paper may be sufficient to affect appreciably the electric strength. Moreover, the construction of three-core cables, no matter how carefully carried out, always involves a heterogeneous region from which it is impossible to remove all air and which becomes a partial conductor when the air is ionised. Confirmation of this is obtained if the dielectric losses of a cable of this type are determined.

In the above respect single cables are much to be preferred to three-core cables; for, in place of the rotating field traversing the heterogeneous layers of the three-core cable, we have in the single cable a radial alternating field at right angles to the layers of paper. If an attempt were made to design a 60,000-volt three-core cable having a potential gradient less than the critical gradient for ionisation (*i.e.*, about 3700 volts per millimetre) the size would be prohibitive.

(*b*) Again, if the problem be examined from the point of view of temperature rise, the conclusion will quickly be reached that the ordinary three-core cable is decidedly inferior to single cables of the same cross section. The heat produced in the copper conductors of a three-core cable cannot be dissipated towards the centre, and consequently only a small part of the surface of each conductor is effective for conducting the heat away.

Experience has shown that this method of considering the problem is correct and that the current-carrying capacity of a 60,000-volt three-core cable is much too low to justify its use in practice.

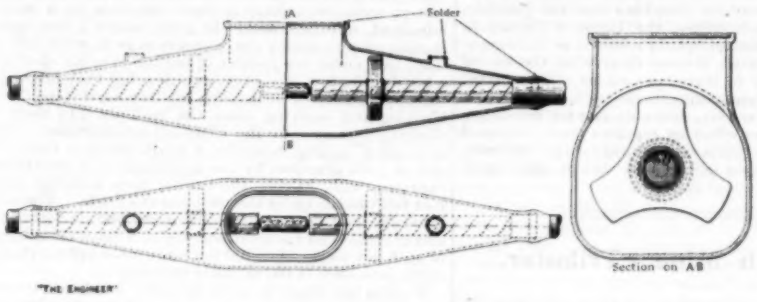


FIG. 1—LEAD JUNCTION BOX FOR 60,000-VOLT CABLES

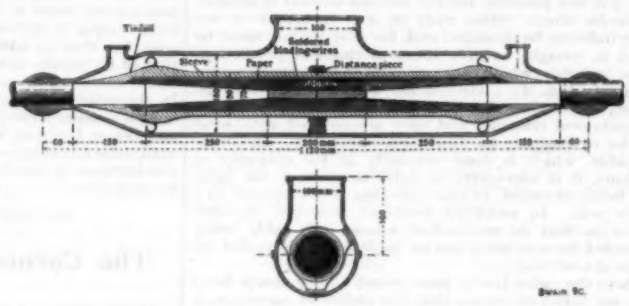


FIG. 2—NEW TYPE OF JUNCTION BOX

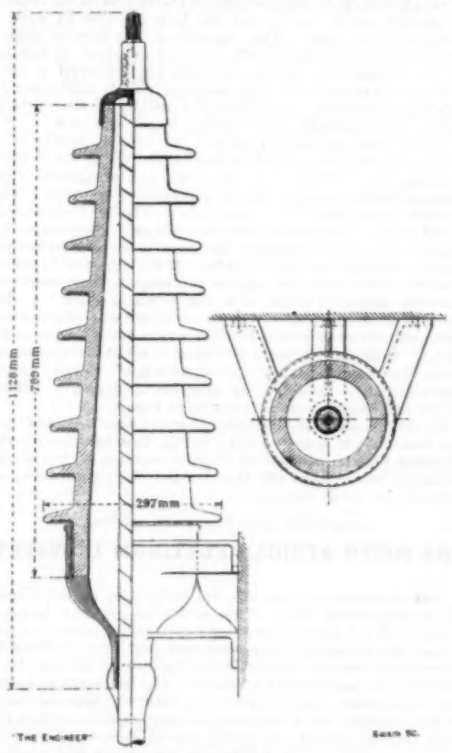


FIG. 3—END BOX

THE SINGLE CABLES OF THE UNION D'ELECTRICITE.

The principal dimensions of the single cables employed are as follows:—Sectional area of copper conductor, 150 square millimetres; thickness of dielectric, 14 mm.; thickness of lead sheath, 2·5 mm. This cable cannot, of course, be protected by an iron tape as in the case of three-core cables, as the energy losses in the armouring would be excessive. The cable is made in 250 m. lengths, and the maximum potential gradient of the dielectric is about 4250 volts per millimetre at the normal voltage.

A curve exhibited by the author showed for such a cable the dielectric losses as a function of the potential difference between the copper and the lead. The curve was very nearly a straight line up to the maximum voltage (about 20,000 volts) used in the test, and showed that the ionisation stage had not been reached.

The normal working voltage being $60{,}000/\sqrt{3}$, *i.e.*, 34,600 volts, it is evident that, as far as the dielectric is concerned, the cable is operating under excellent conditions.

At the normal working temperature of the cable the dielectric losses are smaller than when the cable is cold. The working temperature of the cable is below 45 deg. Cent. It is known, in fact, that for a given voltage the dielectric losses at first decrease slowly as the temperature rises, are a minimum at 40 deg. Cent., and then rise rapidly with the temperature. At 45 deg. Cent. they have about the same value as at 15 deg. Cent.

LOSSES IN LEAD SHEATH.

In addition to the losses in the dielectric and the I^2R copper losses, there are in single cables energy losses due to currents induced in the lead sheath. These currents are of two kinds:—

(1) Eddy currents induced circumferentially in the lead sheath by the magnetic field of the cable. The resistance of the circuit in which these currents flow does not exceed 1 microhm per kilometre length of cable.

(2) Circulating currents which are induced by the magnetic field set up by the current in the conductor and which flow to earth at each junction box. In order to reduce appreciably the circulating currents it is necessary to decrease the resultant magnetic field of the currents in the three conductors, and for this purpose to bring all the cables as close together as possible. The three single cables comprising a feeder should therefore be arranged at the corners of an equilateral triangle.

A number of tests which have been made on different feeders show that the increase in the line losses due to eddy currents and circulating currents is equivalent to about 10 per cent. of the copper losses. On the other hand, the loss due to wattless current is decreased in the same proportion.

At one stage it was under consideration to reduce the above losses by making use of various ingenious devices such as those proposed by Mr. Capdeville, but the complication thereby introduced did not seem justified by the very slight improvement which would have resulted.

CURRENT DENSITY.

Numerous tests have been made to ascertain the temperature rise of the copper conductor relatively to the soil, with the cables laid under normal conditions. A curve exhibited by the author showed the working temperature of one cable as a function of the current. With 300 ampères, *i.e.*, a current density of 2 ampères per square millimetre, the temperature rise does not reach 26 deg. Cent., so that even if it is assumed that the temperature of the soil may be as high as 18 deg. Cent., the temperature of the cable will not reach 45 deg. Cent. From numerous investigations it would also appear that the temperature of the dielectric of these cables does not exceed 50 deg. Cent. under these conditions. A current of 300 ampères may therefore be regarded as the normal rating of these cables, so that their carrying capacity is 31,000 kilovolt-ampères.

It has also been possible to calculate temperature rise curves as a function of the time and in that way determine the overload capacity of the cables.

Assuming the temperature of the soil to be 10 deg. Cent., it is found that a cable having a normal carrying capacity of 300 ampères can carry 600 ampères for fifteen minutes without its temperature exceeding 50 deg. Cent.

The junction boxes—Fig. 1—must, of course, be made of a metal having non-magnetic properties, and, for reasons of convenience and economy, lead has been chosen. Each box is soldered to the sheath of each cable entering it, thus ensuring not only complete water-tightness, but also continuity of the lead. They are filled with compound in the same way as ordinary joint boxes, but their dimensions are such that the potential gradient across the dielectric is lower than that required for ionisation. Each box is earthed to a copper tube 50 mm. in diameter and 1 m. in length driven into the soil.

In practice these boxes have been found to be the least reliable part of the circuit, and although breakdowns in the cables themselves have been completely eliminated, the same cannot be said of the junction boxes. The number of breakdowns is really very small in comparison with the number of junction boxes installed, but the company has nevertheless been experimenting for some time with a new type of box in which the joint is insulated with impregnated paper, the compound serving merely as a mechanical protection—Fig. 2. These boxes have not been in use sufficiently long to enable a definite opinion to be formed of their reliability. Fig. 3 shows a terminal box of the ordinary type.

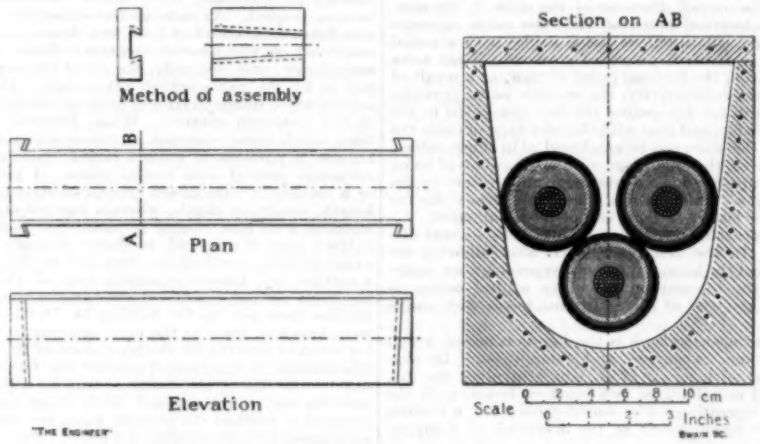


FIG. 4—TROUGH FOR 60,000-VOLT 3-PHASE CABLES

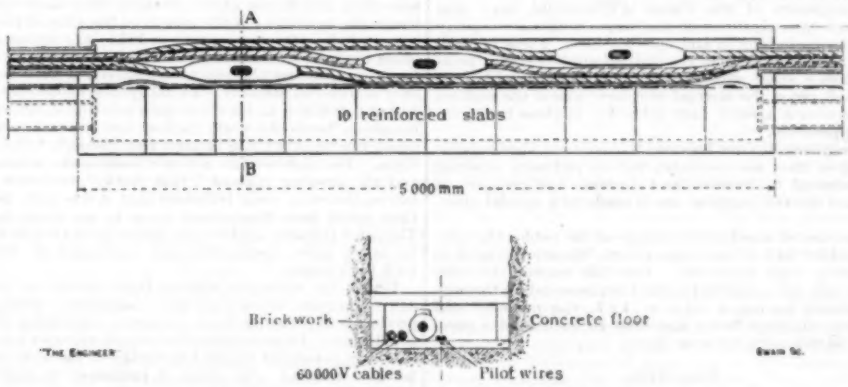


FIG. 5—BRICKWORK CHAMBER FOR JUNCTION BOX

TESTING OF CABLES.

Before any cable is laid the following pressure tests are carried out at the maker's works:—

(1) Twice the working pressure, *i.e.*, 70,000 volts,

between the copper conductor and the lead for one hour.

(2) Three times the working pressure, *i.e.*, approximately 110,000 volts, for five minutes.

The frequency of the supply pressure is 50 in each test.

The engineers of the Union D'Electricité do not specify tests for dielectric losses, as they are of opinion that although such tests are of value to the manufacturer for ensuring uniformity in his cables, or for carrying out special researches, they are not yet a sufficient criterion to estimate the quality of a cable. For instance, they would not reveal a weak spot in the dielectric.

Cable Laying.

As it is not possible, for the reasons already indicated, to provide single cables with an iron sheath, they are rather liable to be damaged and, for that reason, must be placed in troughs to give them mechanical protection. These troughs, which are of reinforced concrete, are U-shaped—Fig. 4. The cables automatically arrange themselves so that the lines joining their centres form an equilateral triangle, and they are covered with sand in order to dissipate the heat more effectively. In laying the cable, which is done manually in the majority of positions, it is necessary, in order to prevent the cable from being damaged, to take care that it is subjected to a steady pull. In awkward positions, however, recourse has to be had to mechanical means, the cable being suspended from a steel carrier cable which is pulled by means of a winch.

Where the cable has to pass round a very sharp bend steps are taken to ensure that the radius of curvature is not less than 1 m. and to strain as short a length of cable as possible, junction boxes being installed, if necessary, at the start and finish of the sharp bend.

The junction boxes are protected by brickwork as shown in Fig. 5.

Three-phase Cables with Equipotential Surfaces.

As an experiment, the Union d'Electricité is at present laying a few lengths of 60,000-volt three-core cable of a new type. The cable consists of three insulated cores, and over these is wrapped a layer of metallic paper which constitutes an electrostatic screen throughout the whole length of the cable. A lead sheath encloses the whole and is itself protected by iron armouring in the usual way. The cross section of each conductor is 150 square millimetres and the overall diameter of the cable is 108 mm.

From the electrical point of view the cable operates under the same conditions as single cables with a radial field and an equivalent potential gradient. Tests have shown that, from the thermal point of view, as a result of its high thermal conductivity, the metallic paper provides a sufficient path for dissipating the heat generated in the centre of the cable, and that with this new type of cable the same current densities can be employed as in single cables. It has, moreover, the advantage over single cables of being less liable to injury and of rendering it unnecessary to use special troughs. In addition, the extra losses due to currents in the lead sheath are completely eliminated.

On the other hand, this type of cable has several disadvantages. In the first place, even after allowing for the troughs and the laying, it is more expensive than single cables, and the interest on the extra capital outlay is greater than the cost of the additional losses with single cables.

Another serious drawback is the junction boxes, which are cumbersome, expensive, and complicated. In particular, the repairing of a fault, which involves the dismantling and rebuilding of two junction boxes, puts the cable out of operation for a considerable time, a feature which is very inconvenient in the operation of a supply undertaking.

Pressure Rises and Surges.

Several investigations of pressure rises and surges affecting the working of the system have been carried out and the results have already been published.†

The wave form of the turbo-alternators at Gennevilliers and Vitry is almost sinusoidal, and any tendency of the harmonics to become serious would be taken care of by the magnetic saturation of the step-up and step-down transformers.

Apart from this, investigations have shown that the risk of pressure rises due to resonance of the harmonics in the wave forms of the alternators can be entirely disregarded, notwithstanding the very unfavourable conditions which exist in the system.

The engineers of the Union d'Electricité have also carried out investigations on the surges which accompany the sudden switching in and out of cables. These investigations have proved that the sudden application of pressure causes a surge which in the most unfavourable case may reach twice the normal pressure, whilst the sudden disconnection of a cable may subject it to three times the working pressure.

The engineers do not hesitate to carry out these operations when they are essential, but in ordinary working it is preferred to increase and decrease the pressure in steps, and for this purpose use is made of a special alternator.

In the case of a sudden discharge of the cables the telephone cables laid in the same trench become charged to a relatively high potential. For this reason the subscribers' sets are connected to the telephone cables through transformers having a ratio of 1 : 1, the primary and secondary windings being insulated to withstand a pressure of 60,000 volts between them.

Test Sets.

The Gennevilliers station is provided with a special motor generator set for the testing of, and the gradual application of pressure to, the 60,000-volt cables.

The set consists of a synchronised asynchronous motor of 600 horse-power coupled to a 6000 kilovolt-ampère three-phase generator, and a 6000 kilovolt-ampère 6000/60,000 step-up transformer. The generator is so designed as to give with perfect stability its maximum power with a leading power factor of $\cos \varphi = 0$. Its rotor is provided with a strong amortisseur which enables it to work as a single-phase machine.

By means of this set it is possible gradually to raise the pressure to 60,000 volts on a three-phase feeder 30 kiloms. long, and also to apply between phases and between each phase and earth a single-phase pressure of 70,000 volts.

† J. Fallou, paper presented to the International Conference on High-tension Lines, 1925.

Conclusion.

Four years' experience enables the Union d'Electricité to state definitely that a network of single cables working at 60,000 volts between phases is quite satisfactory from the point of view of reliability, provided that suitable precautions are taken in installing and, especially, in designing the junction boxes.

After carefully examining the construction of three-core cables manufactured for the same voltage by the best-known firms of various countries and the junction boxes required for such cables, the Union d'Electricité considers that no advantage would result if in the extension of its supply network it were to give up the use of single cables in favour of three-core cables of any make. In the opinion of the company, single cables involve not only a smaller initial outlay, but also greater reliability and better facilities for effecting repairs; and compared with these advantages such a disadvantage as, for instance, the increase in the losses in the lead sheath, appears to be negligible.

The Cornish Mine "Tributer."

In the course of a paper which he read before the Cornish Institute of Engineers at Camborne, on Saturday, December 4th, Mr. A. K. Hamilton Jenkin gave an interesting history of the "tributer," who, he remarked, was formerly considered one of the most valuable assets in the economy of Cornish mining, but was now, alas, becoming all too rare. A tributer was a man who, in lieu of an ordinary weekly or monthly wage, agreed to work for a percentage of the total value of the ores he sent to the surface after paying the cost of all the tools and materials necessary for winning the same.

A tributing system seemed to have been in existence, in one form or another, in almost every metalliferous mining district of the world, and it was in general use in Cornwall at a very early date. It was certainly applied to the old alluvial tin streaming even before underground mining became general. As early as the sixteenth century there was direct evidence of at least two classes of tinners being employed in the alluvial streams:—First, the working adventurer; and, secondly, the hired labourer, or spaliar, put in by the non-working adventurer. The system of setting whole mines on tribute died out about the beginning of the sixteenth century. What, however, had always been much more common in mines was the setting on tribute of portions of ground called "pitches," and this remained general until recent years. A pitch consisted of a section of mineralised ground of strictly determined length, height or depth, wherein the tributer and those working with him—called a "pare" of men—agreed to extract what they could, receiving so many shillings for every pound's worth of ore they sent to the surface. On a certain day, known as setting day, all the tributers in the mine having assembled outside the count house the pitches were put up for bidding by Dutch auction, and were knocked down to the pare agreeing to work in each for so many months for the least share of the value raised. The bidding in this form of auction was frequently closed, not by the tap of the hammer, but by a pebble thrown into the air by the captain, offers being made until the moment it reached the ground, when the last bidder was considered to have secured the pitch. By the eighteenth century the old non-working adventurer had developed, in all large mines, into the adventurer or shareholder of the present day. The working miners were, however, still divided into two classes—the "tut-workers," or men on contract, and tributers.

Development work, such as shaft sinking, driving cross-cuts, &c., was generally done on contract, tributers being employed only on the extraction of the actual lode stuff. Of these two sorts of mine labourers tributers nearly always made the better earnings. In spite of his nearly equal risks and hardships the tut-worker was generally looked upon as an inferior grade of worker, and the ambition of the more intelligent boys was always to become tributers. It was not always that the miners found themselves coming to "grass" too early, for in those days many of the men were very indifferent about the time they came up. Towards the beginning of the month or the time of taking up a new pitch—stated a captain in 1864—the tributers were often inclined to leave work early, but as the time drew to an end, unless the pitch had proved a very bad one, they worked on steadily. In many cases where a tributer had cut rich and had a short time left before surrendering his pitch, he would work the last few weeks like a slave, doing twelve or sixteen hours a day instead of the normal eight. The sight of the rich ore continually before them, and the growing piles of "best work," exercised such a fascination over some tributers that it was with difficulty they could tear themselves away to go home to sleep. Though a tributer might make £50 or even £100 in a month he much more frequently only succeeded in deserving such high wages.

Under the tributing system boys started at an early age to acquire knowledge of a dangerous calling which produced in many of them miners of unrivalled skill and intelligence. In most cases the Cornish tributer's existence formerly depended on his knowledge of the lode in which he was working. An error of judgment in making his two or three monthly bargain might entail semi-starvation to himself, his wife and family, and the swallowing up in a short space of time of all the hard earned gainings of years.

That the tributers' system had its defects all who knew the internal history of the mines would admit. The policy of the adventurers themselves was sometimes dishonest and often short-sighted. The agents, too, in their anxiety not to be "baffled" by the miners, sometimes engendered hostility and distrust. "Capuns," so the old tributers would relate, often went too much by the books—that was to say, the average earnings of those who had previously worked the pitches of particular lodes—and too little by the actual conditions of the lodes at the time of resetting. Owing to a still more short-sighted policy which obtained in some mines the trubuters were not allowed to earn more than a certain sum per month, with the result that in many instances the men refrained from sending their best work to grass, knowing that if they did so their rate of tribute would be reduced on the next setting day. The result of such a policy was an ultimate loss to men and adventurers alike.

Worse than this, instances had not been wanting, as every old tributer knew, in which contracts had been interrupted simply because the men "were doing too well." That was especially the case where the mine itself was losing money, and when the agents, as a result, felt themselves unable to go before the adventurers with a high wage bill. But if the adventurers and their agents—the captains—were sometimes sharp in their practices so, it must be admitted, were the men. In some mines it was quite a regular custom among the tributers to go to work early and leave late under the pretext of having to make up time on a poor pitch, but, in reality, in order that they might have the opportunity of going into the "owners' stopes" after blasting and carrying away the best ore into their own working places. In the diamond-cut-diamond method of Cornish mining, however, a fairly effective check was put on such practices by the appointment of underground captains, who, having themselves been working miners, had full knowledge of the tricks of the trade. These men generally had fixed salaries of about £80 or £90 a year, and it spoke well for their honesty as a class, that, in spite of such low wages, they did not more often fall into bribery and connivance in the tricks of the men.

For the last thirty years or more the number of tributers in Cornwall had been declining. Dolcoath Mine was employing a fair number of them down to the late stoppage. To-day they would hear it stated that the tributer had disappeared altogether from the county, but although their number had become alarmingly small, he was glad to say it was not quite so bad as that. While perfectly aware that no hard and fast rule could be laid down for all mines, and that in cases where large quantites of low grade ore were being extracted from massive lodes, there were doubtless very good reasons for not employing tributers, if they considered some of the mines situated between St. Ives and St. Just, where the lodes were exceedingly rich but very narrow, the case for tributers did demand attention. Even if the tributer's day in the majority of the larger mines was over, there was still much scope for his employment in "free setting." The value of such men's labour to the mineral lords in prospecting the countryside was obvious, for the discoveries they made often led to the opening up of regular mines.

What ordinary investor, it might be asked, would risk so large a proportion of his savings in the concern as these men did. If a working man was prepared to adventure so much money, to say nothing of the labour of his hands, he should surely receive all the help possible in such a commendable cause. The opposition of a farmer might, perhaps, be excusable when it was a question of having his land disturbed, though he generally received a very good compensation for any damage which might occur, but the opposition, or at least the apathy of the mineral lords, was amazingly short sighted, to say the least.

There were still plenty of men left in the county who knew tin, and who would rather be searching for it than drawing the dole. But without encouragement that class of workmen would die out altogether very soon. The Cornish Institute of Engineers knew as a body the resources of tin which remained within the county. They knew the shallow pits which dotted the moorland and indicated many practically unworked lodes. If they went to London, however, and asked for capital to prospect they would at once be asked, "What can you actually show?" He made bold to say that it was the tributer who could show them the tin they wanted under such conditions, and he alone. If he was properly encouraged, a fair remuneration given him for his risk and outlay, he might continue yet to stimulate their industry, by opening up prospects which might afterwards become important mines.

In conclusion, Mr. Hamilton Jenkin said he could not but feel that it was the duty of the Institute, as a body interested in the position of Cornish mining, to use all its influence to see that the tributer got the encouragement which he so richly deserved.

THE SOUTH AFRICAN PLATINUM INDUSTRY.

The statistics of the mineral industries of the Union as at December 31st, 1925, compiled by the Department of Mines show that the total nominal capital of the Transvaal platinum companies was just over £4,500,000. Since that time the Onverwacht Platinum, Ltd., has been floated, with a capital of £450,000. The platinum industry may now claim, nearly three years after the first discovery of the metal in the Transvaal, to have passed through the most trying period to which initial mining is usually subjected—the period between development and production. Up to the present there is no reason to feel disappointed with the results achieved, in spite of the fact that, owing to failure to extract the metal from the rock, one mine has closed down until the metallurgists and chemists shall have evolved a process which will recover a reasonable percentage of the metal. The platinum in this case occurred in a totally different formation from that of the other districts in which platinum has been found. In all the other fields the platinum occurs in dunites and norites, and while some difficulty was experienced regarding extraction from the norite, it has now been practically overcome. The Onverwacht Platinum, Ltd., was the first mine to get to work on dunite ore, the others not yet having come to the production stage, with the exception of one which started about two months ago, and from which a declaration of production may soon be expected. Since the Onverwacht mine began to produce, in February of this year, and up to September 30th, it has crushed 9322 tons, from which 4524 oz. of platinum have been recovered. The tonnage crushed per month was low for the first three months, but has been about 1350 tons monthly from May on, and the plant is being enlarged so as to increase the tonnage and further improve the percentage of extraction. The average yield per ton is 9·7 dwt., but results obtained on the 350ft. level seam, it is reported, to indicate that it may run less on that horizon.

Railway Matters.

OWING to continued ill-health, Mr. E. J. Neachell, the general manager and engineer of the Liverpool Overhead Railway, has resigned, and has been succeeded by Mr. W. T. D. Grundy, the general manager of the Derwent Valley Railway, York.

THE opening sentences of the description of the resignalling of Cambridge, which appeared on page 642 of our issue of December 10th, need amendment as regards the route taken by down and up trains entering the station. The normal course in both cases is by the scissors crossing, but if the through line be occupied a down train could use the through road A A, and an up train the crossover D D.

WITH a view to discourage passengers from throwing litter on the platforms and track, the Underground authorities are about to install wire litter baskets at their stations. That is an example which, we suggest, other companies might follow. What can be done at Aberdeen Station can be done elsewhere. Litter on the line not only is disfiguring, but its removal places the men doing the work in a position of danger.

WHEN Sir Josiah Stamp was speaking at the railwaymen's demonstration at Belle Vue, Manchester, on September 26th, he made some comments on the appearances of the American locomotives, in contrast with the smart appearance of English engines. That has led our New York contemporary, the *Railway Age*, to say that the American railways are to-day giving more attention to that matter than they did, and that one road had gone frankly to the English type locomotive. Other roads, quite as interested in imposing appearances, have restricted themselves to surface treatment—more and brighter paint, polishing, and cleaning.

A COUPLE of railway accidents occurred on the London and North-Eastern Railway last week. As the evening down express from York to Newcastle on Sunday was near Croft—just south of Darlington—an axle of the tender of the engine broke. Considerable damage was done to the permanent way, but no derailment of the coaches was reported. The following morning, during a dense fog, there was a collision between two goods trains which caused the up main line between Darnall and Woodhouse to be fouled. Before the necessary steps could be taken to protect the line a workmen's train ran into the obstruction. Nineteen passengers were hurt, but none seriously.

IT is announced that at a meeting of the Cheshire Lines Committee, held on December 14th, Mr. Alfred Percy Ross, M. Inst. C.E., engineer of the Cheshire Lines Railway since March, 1917, was appointed manager, in succession to the late Mr. W. H. Oates, whose death occurred in November, and Mr. T. R. Smith was appointed secretary to the Committee. The new manager, who is the son of the late Mr. Alexander Ross, at one time the district engineer of the London and North-Western Railway at Edge Hill, was educated at Manchester Grammar School and at the University School and College, London. Before taking up his appointment as engineer to the Cheshire Lines at Liverpool, he had been engaged as the assistant engineer to the Great Northern Railway at King's Cross Station. The news of his promotion to the position of manager and engineer will be welcomed by a wide circle.

AT the time when the control of the railways ceased all exceptional rates were, and had been since September, 1920, 100 per cent. higher than in 1913. In May, 1922, they were reduced to 75 per cent. above; in May, 1923, to 60 per cent., and in July, 1923, to 50 per cent. higher. On June 12th last all the companies gave notice that, as from June 29th the rates would be increased to 60 per cent. above. It was at once contended by traders that such an increase could not be made without the consent of the Railway Rates Tribunal, but the companies replied that under section 60 of the Railways Act they were, until the "appointed day," entitled to make such charges as were in force on August 15th, 1921—the date of the Railways Act. In passing it may be noted that the "appointed day" has not yet been fixed. A test case was, therefore, brought before Mr. Justice Astbury, who pronounced for the railway companies, and that judgment was confirmed in the Court of Appeal. In due time the case was carried to the House of Lords, and there, on Friday last, December 17th, the further appeal failed. It should be added that in the section in question there is a proviso that a representative body of traders or a single trader or a railway company "may apply" to the Rates Tribunal for a reduction in charges. The appellants contended that that was imperative, but the Lord Chancellor said that such a construction would negative the first part of the clause and, in his opinion, the argument on the construction of the section failed.

YESTERDAY, December 23rd, was the fiftieth anniversary of one of those railway accidents which for many years led public opinion to expect a serious disaster at Christmastime. That was the collision at Arlesey Siding Station on the Great Northern. At that period the block rules allowed a section to be considered clear unless a train was in it, and, further, there was no blocking back rule. As a consequence, the line was indicated as "clear" when the first portion of the afternoon express to Manchester was signalled, and the down line was not blocked when an up goods train was shunted over it. Some wagons on the latter were derailed, but there was only a distant signal 898 yards from the wagons to warn the express. A collision resulted, in which four passengers and the two enginemen were killed. The wheels of the engine were fitted with the vacuum brake, but not those of the tender nor of the fifteen coaches. In its issue of December 29th, 1876, THE ENGINEER observed: "In the same way as at Abbotts Ripton—on January 21st of the same year—lives would have been saved and thousands of pounds of property preserved to the company if the down express had been fitted with a continuous brake. Dozens of examples of the same truth may be cited by any railwayman who has his notes by him. The only question now remaining to be dealt with is how many more collisions are to take place before railway companies begin to understand that when they have provided powerful engines to haul a train at high speed they have done but half their work, and that an efficient means of taking the velocity out of the train in the smallest space of time is just as much needed."

Notes and Memoranda.

THE work carried on by the Mines Branch on the deposits in Western Canada, has proven up the presence of hydrous salts, mainly sodium sulphate, to the extent of about 115,000,000 tons.

GEOLOGICAL calculations on a conservative basis of the shale oil which exists in Tasmania, are that the deposits amount to more than 43,000,000 tons, containing, on an estimate, 40 gallons of crude oil to the ton, or 2,000,000,000 gallons.

IT is claimed that two Diesel-electric tugs, which have been put in service on the Panama Canal, are the largest of their kind. They are 150ft. long, and each has two 480 horse-power engines. The propeller motor is of 750 horse-power.

IT is claimed that the bridge which is being built across Montreal Harbour will rank second only to Sydney Harbour Bridge. It will be of the cantilever type with a main span of 1097ft., two side spans of 420ft., and several approach spans. There will be room for four lines of road traffic, two tramway tracks and two footways. The head room for navigation will be 163ft.

THE differential separation by flotation of lead and copper from zinc in sulphide ores is, according to the American Bureau of Mines, developing rapidly. There are several operating plants in which this treatment is successfully installed, and while the separation of the minerals from each other is not quite as clean cut as in lead-zinc-iron separation, still developments are promising, and it is quite safe to predict that sulphide ores of almost any variety will yield, under proper conditions, products of each mineral that are of high grade and comparatively free from other minerals present in the ore.

ONE of the largest flood-prevention, irrigation and hydro-electric enterprises ever undertaken in Mexico was announced recently in a contract signed by the Mexican Government and the Mexican Light and Power Company, a Canadian corporation. The project will involve an expenditure of about 18,000,000 pesos—about 9,000,000 dollars. The contract calls for the construction of a concrete dam across the river Lerma near Contepec, in the State of Michoacan. The dam will impound 500,000,000 cubic metres of water, which will be used in irrigating more than 50,000 hectares of agricultural land, as well as furnishing power to a hydro-electric plant.

THE official report on the explosion of a flexible steam pipe, 3¼in. in diameter, used at a Liverpool oil jetty, emphasises the liability for the pipe to fracture at the point where it is attached to rigid connections. It is pointed out that no provision was made to prevent the flexible pipe from being unduly curved at the flange into which it was secured, and it is evident that the material was overstrained at a part where a crack in the material could not be detected readily. Although the owners have now decided to replace the original pipes by stronger ones having a stiffening arrangement to prevent overstraining at the flanges, they should not neglect to examine and test these pipes periodically. Incidentally the owners have fitted brass funnel-shaped pieces 11in. long on the connections of the new pipes.

A NOTE in *Industrial and Engineering Chemistry* advocates the use of ethylene dichloride as a solvent for oils and fats. Its solvent action is said to be superior to that of the better known extraction agents, and it is extremely stable in the presence of water, alkalis, or acids. It may be used in the presence of free chlorine, sulphuryl chloride, sulphur monochloride, and other active reagents without being affected. Being quite resistant to oxidation it does not split off hydrochloric acid and produce oxidised products as do chloroform or carbon tetrachloride; hence it may be re-used or stored indefinitely. It does not corrode metals even in the presence of water at the boiling point, and having low specific heat, density, and latent heat, it may be recovered easily and economically. At ordinary temperatures, it will burn only with difficulty.

WHILST it was admitted that no air line unaided by State assistance can at the present time compete with other means of transport, Captain F. L. Barnard, in the course of an address in Manchester to the North-Western Section of the Institute of Transport, held that when all the incidental charges of sea and rail travel are taken into account, the total cost on such air routes as those between London and Amsterdam, Basle, Zurich or Cologne is often no greater. Enormous sums of latent capital, moreover, have to lie more or less idle in such auxiliaries as permanent way, tunnels and docks, and such a factor must tend to prevent land and water transport from ever becoming really cheap. Captain Barnard affirmed that aerial transport, on the other hand, operates in one medium only, with the additional advantage of being able to depart and arrive on land, sea or river, and that therefore large sums of money are not locked up in non-revenue producing accessories.

THE estimated value of the gold produced in the world from 1860 to 1924, inclusive, was 15,081,683,600 dollars, states J. P. Dunlop in a report recently issued by the American Bureau of Mines. In 1924 the estimated production of the world was 389,169,700 dollars, an increase of 21,316,300 dollars over that of 1923. This increase followed a period of successive annual decreases from 1915 to 1922, and an increase of 48,433,300 dollars in 1923. The production in 1924 in the United States increased 543,000 dollars. In Africa the increase was 9,276,300 dollars, or 44 per cent. of the total increase in world output. The production in Canada increased about 6,000,000 dollars, or 24 per cent. The large increase in the Rand mines in South Africa was due to the absence of labour troubles and to the steady working of the mines all the year. The prevailing tendency during recent years toward a declining world output of new gold, caused by the high cost of labour and supplies, which made the operation of many gold mines unprofitable, has been modified to some extent by greater political and financial stability in some countries, which will tend to increase operations or the reopening of old properties. This will temporarily result in relatively small increases over the abnormally low output of gold from these countries in the last six or seven years.

Miscellanea.

A NEW ironworks has been put up at Hangchow, China, for the manufacture and repair of silk weaving machinery.

ACCORDING to an estimate made by the Colonial Secretary, the purchase of rubber by manufacturers for the current year is approximately 550,000 tons.

THE hydro-electric power plant which is being built on the St. Anne River at St. Alban, Quebec, will develop 4000 horse-power and the cost is put at 600,000 dollars.

IT is announced that Mr. D. H. K. Bottrill, an Australian metallurgist, who is engaged in research work at McGill University, Toronto, has discovered a process of welding aluminium with Thermit.

THE battleships H.M.S. Ajax and H.M.S. King George V. are to be broken up at Rosyth by the Alloa Shipbreaking Company, Ltd., which recently bought up the Rosyth Shipbreaking Company.

A NUGGET of gold weighing 101 oz. 3 dwt. was, according to the *Mining Review*, unearthed recently at St. Ives, Western Australia, by William Douglas, a prospector. When smelted it yielded 81 oz. 8 dwt.

THE price of Japanese coal delivered in Shanghai is, according to the latest official Government reports, some 14s. per ton for "lump" stuff. Kaiping coal is a little less costly and coke is about 22s. a ton.

ACCORDING to a Californian paper, the Chanslor-Canfield Midway Oil Company intends to put its Olinda No. 96 drill hole down to a depth of 10,000ft. At present the well is 8046ft. deep, probably the deepest hole ever drilled.

A SCHEME for the development of tidal power on the Tay has been put forward by Professor A. R. Fulton. It is estimated that it would provide 11,700 horse-power, continuously, and cost £1,450,000, or some £124 per horse-power.

IT is announced that the contracts for a large sewerage scheme at Oruro, Bolivia, and for a canal to connect Oruro with the Desaguadero River, have both been secured by this country. The total value of the contracts is about £600,000.

THE Telephone Administration of Dairen, Manchuria, is installing automatic telephones in place of the old system. New equipment has been ordered from America and the work of installation is expected to be completed before the end of the year.

A HYDRO-ELECTRIC power plant with a 2,000,000 kilowatt capacity is, according to the *Far Eastern Review*, to be erected with a capital of Y.200,000,000 somewhere along the Yalu River. The project includes the erection of a plant for magnesium alloys.

SOME promising occurrences of mica are being prospected in the Piet Retief district, at a distance of some eight miles from Kemp Siding, on the Ermelo-Piet Retief section of the eastern line to Natal. Large bodies of pegmatite carrying the mineral are in evidence.

THE British Treasury has announced its willingness to guarantee principal and interest to an amount of £110,000 under the Trade Facilities Act to the Australasian Paper and Pulp Company, Ltd., Melbourne, for twelve years, for the purchase of materials and machinery in Great Britain for mills in Victoria.

IT is suggested that Rangoon should be supplied with water by damming the Salwin at a point some 150 miles distant from the town. The dam would be 300ft. high, and would provide a reservoir 40 square miles in area at an elevation of 2800ft. The water could also be used for developing power.

A PROPOSAL has been laid before the Brazilian Congress for the improvement of the Port of Ilheos, on the southern coast of the State of Bahia, at an estimated cost of 4,600,000 milreis. The work would include the dredging of a channel, the construction of an anchoring basin, and the erection of masonry docks, retaining walls and two large warehouses.

SOME indication of the importance which the electrical business of the country attaches to the forthcoming British Industries Fair at Birmingham is given by the announcement that, out of twenty-seven delegations which are to be received during the progress of the exhibition, no less than eleven are directly connected with electrical industries.

THERE has of late, says the *S.A. Mining and Engineering Journal*, been a revival of interest in the prospects of finding a source of oil in South Africa. The South-West Petroleum Corporation's boring operations have reached a depth of 500ft.; drilling will shortly be started at Gruisfontein, the site of the interesting occurrence of natural gas some 60 or so miles to the south-east of Johannesburg; Dr. Merensky has in the course of an interview expressed himself hopefully concerning the suitability of South African coal for the so-called "liquefaction" of coal; and finally it is announced that it is proposed to exploit the Transvaal torbanite deposits, concerning which local engineering and geological opinion has for some time past been very optimistic.

WORK on the new outer harbour at Macao has progressed most actively during the year, and hopes are entertained of its completion by the end of 1926. The encircling breakwaters, of an aggregate length of 2700 m., are either completed or in full course of construction; the foreshore reclaimed, with retaining walls some 3000 m. long, will cover an area of about 175 acres, and space for the erection of godowns, the rapid and easy handling of cargo, and provision of all the many needs of a busy port will thus be conveniently available; the channel leading to the open sea is being effectively protected against silt, and preliminary dredging of the harbour to a depth of 12ft. at low water of spring tides have been effected; steamers bringing supplies and drawing 20ft. or so have already anchored and worked within its limits. In connection with the general plan a dry dock for tugs and steam launches has recently been opened and an excellent and spacious typhoon anchorage for river steamers and junks is now provided near the existing inner harbour. Here, also, an extensive area has been reclaimed, and this land is being rapidly taken up for industrial purposes.

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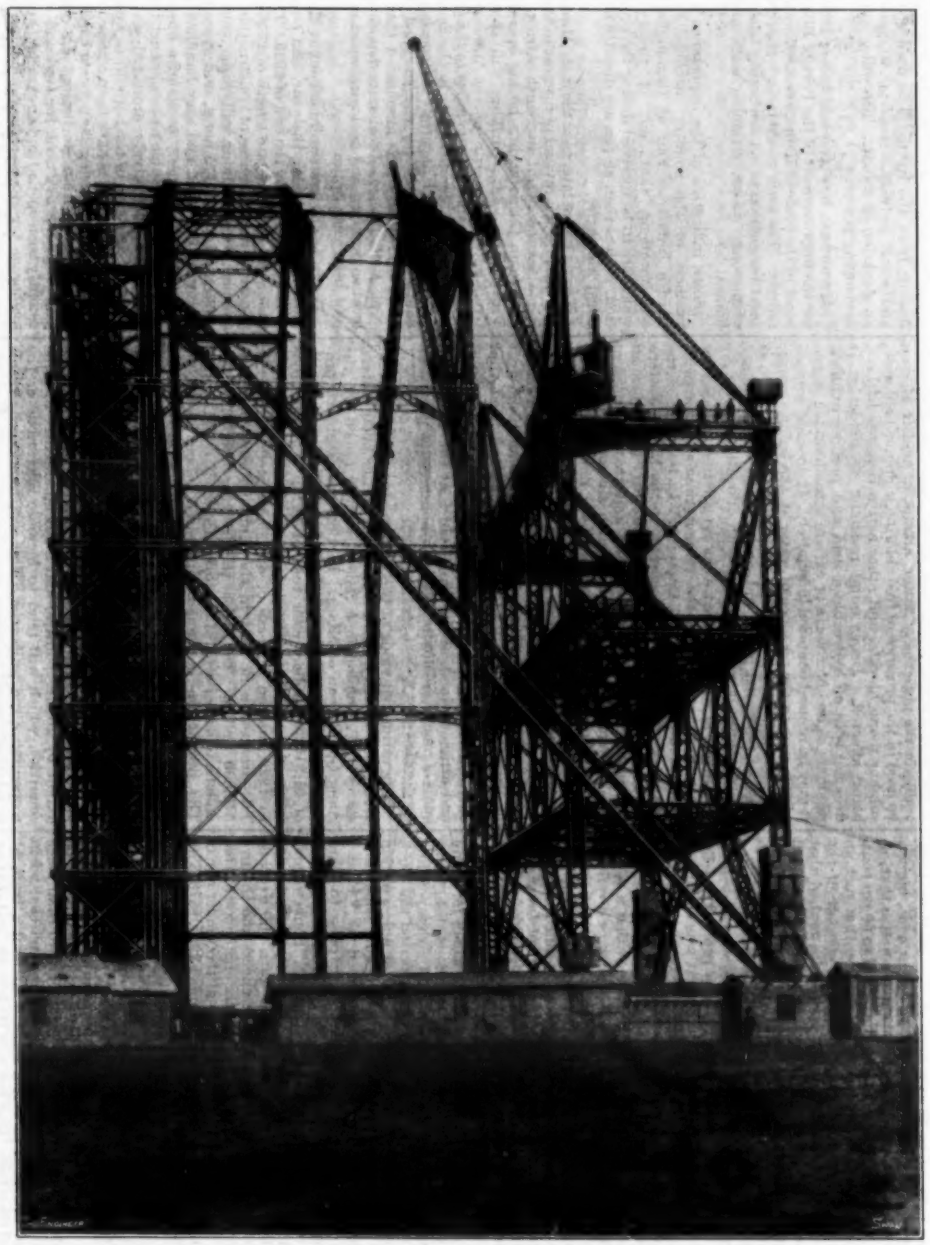
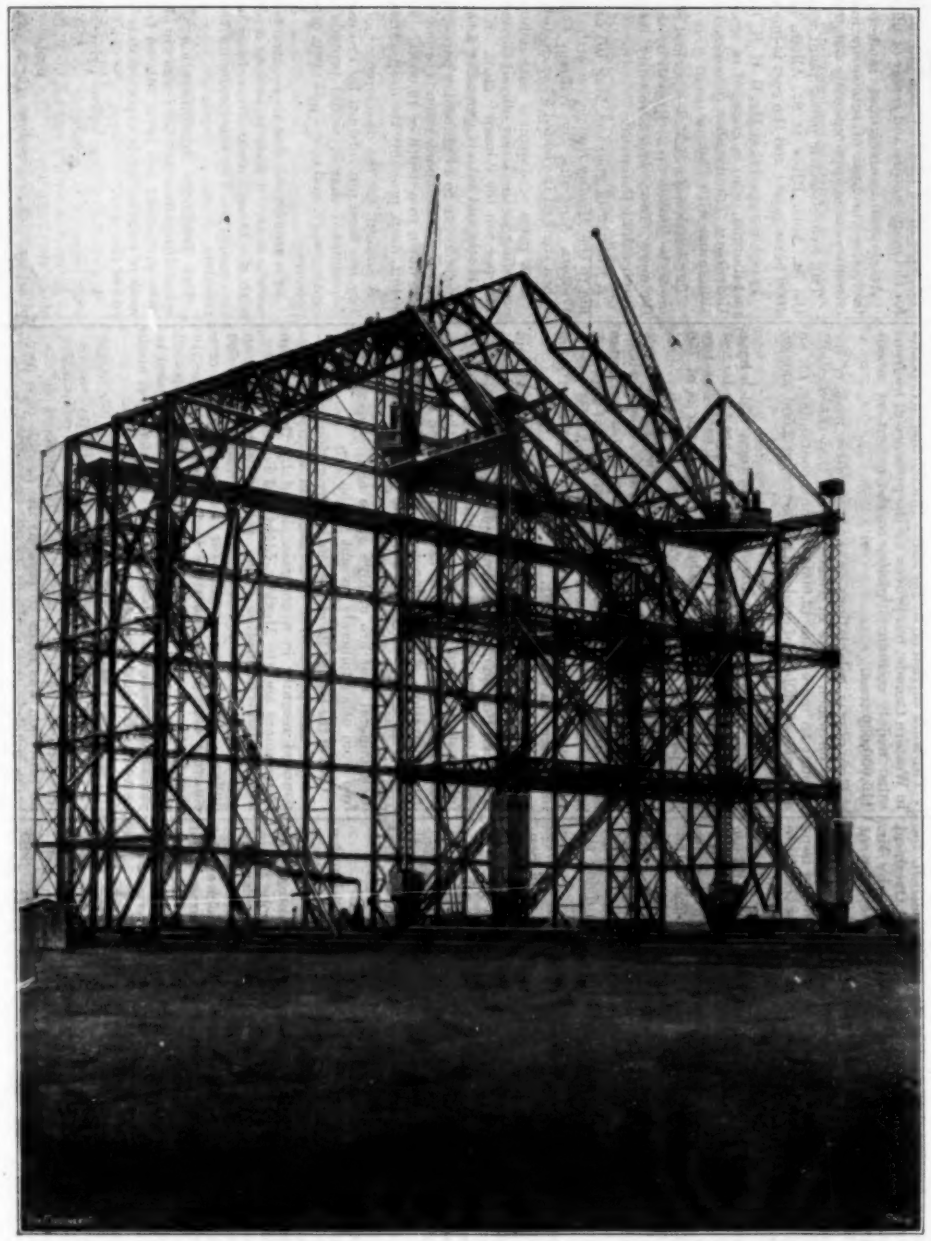


ERECTION OF THIRD RIB LOOKING NORTH—NOVEMBER 26, 1926



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THE ENGINEER.

DECEMBER 24, 1926.

Peace in Industry.

WE have read with much interest an article entitled "Peace in Industry," which appears in the *New Statesman* for December 18th. It is unsigned, but is clearly from the pen of one whose sympathies are on the side of Labour. We do not quarrel with it on that account. Rather are we pleased to find that that party has a spokesman who can speak with moderation and one whose object is rather the reconstruction than the destruction of industry. Our author, indeed, threatens us with further industrial troubles as soon as we begin to recover from the depression caused by the coal dispute—which he boldly and illogically calls a "lock-out"—but at the same time he suggests a line of procedure which he believes might avoid that catastrophe. His cure is not one of the paper panacea of which we have had more than enough to convince us of their uselessness. There is no question of a bond between employers and employees, no question of setting up new panels or committees or arbitration authorities, or any machinery of that kind. The cure is to be found within the boundaries of the industries as they exist. All that is required, according to our author, is that industry should be reorganised so that it can "stand the burden of a reasonable living wage." "If," says our author, "the employers in the leading industries would now make a plain declaration that they will attempt no further cutting of wages, that they will in no case increase the working week beyond a maximum of forty-eight hours, and that they are ready to give a plain guarantee that the results of increased productivity shall be applied in the first place to improving working-class conditions, the movement towards industrial peace will at once acquire a substance and an appeal which it at present lacks." Having made these promises, employers could "fairly ask" the workers for a corresponding change of attitude and the Government for temporary assistance.

It will be observed by the careful reader that, whilst the employer is invited to make definite proposals, he can only "ask" the workers to meet him halfway. Our author is cautious. He is clearly not prepared to say that the reply would be favourable. He probably knows as well as we do that it would not be; that there would always be some one to fan the flame of "divine discontent" and many ready enough to take fire from it. If labour troubles were purely industrial, if the political element could by any means be extirpated from them, there would be some chance of such a consummation; but there is none, absolutely none, as long as trades unions can be used for party purposes. To that fact we must reconcile ourselves. It must be taken into account in all our calculations. As soon as the strike became a political weapon the whole position changed. It could not be dealt with by ordinary industrial means, and when such means do succeed in obviating or removing trouble it is because they override the political motive. But that motive always remains, and unless means of checking it are found—as, for example, by the secret ballot—sooner or later declares itself. In such circumstances no one dare say that any method, howsoever good it might be, would prevent the occurrence of labour disputes. The first step towards real peace is the complete divorce of politics from industrial questions. That being achieved, progress in the direction which our author indicates might follow. Yet it should be observed that the guarantee for which he asks is distinctly one-sided. It all falls upon the employer; he is not to lengthen hours or shorten wages; he is to reorganise his factory and his method, and finally he is to promise that the "results of increased productivity shall be applied in the first place to improving working conditions." What is Labour prepared to do in exchange? Our author makes no promise on its behalf; all he can say is that it could be "fairly asked" for "a corresponding change of attitude." He may exclaim with Glendower: "I can call spirits from the vasty deep," and we reply with Hotspur: "Why, so can I; or so can any man. But will they come when you do call for them?" Moreover, the purchaser appears to be left out of the bargain altogether—not an uncommon fate when Labour is instituting reforms, for it too often forgets that there are always three parties interested in industrial changes. In the interests of the purchaser it is not reasonable to ask the employers to devote "the results of increased productivity" to labour. If that were done, there would be no reduction in price and no improvement of the market. Without an improvement of the market the reorganisation for which our author asks would be fruitless. The employers are perfectly prepared to share the advantages accruing from increased productivity between the workers, themselves, and the purchaser. That is sound business. But to reorganise a factory simply for the "improvement of working-class conditions" is an impracticable scheme. The object of any reorganisation must in general be reduction in price. Here and there it is just possible for the employers and the employed to share the improvement between them. But that is not the rule. In ninety per cent. of all cases competition is effective and some portion of the reduction of manufacturing costs must be passed on to the purchaser. Furthermore, the "manufacturer" himself has a perfect right to enjoy some of it. He has had to find brains for the invention of new machines and methods and capital for their realisation. The factory is not run, as some Labour doctrinaires ask us to believe, just in order to give employment. It is run to satisfy purchasers and make a reasonable profit for shareholders. It is only by appreciation of the fact that the interests of the employer, the employed, and the purchaser are one that industries can hope to make progress.

There is ample evidence of the new spirit in the engineering industries of this country. Apart from bad employers—who form but a small portion—there is a general desire to pay by results and to introduce methods which will enable the workers to produce more per day. The idea of the fixed wage is much dearer to the heart of the workman than to the employer. The latter knows that it is rarely profitable, and he would far rather employ means which would automatically provide the workman with an incentive to work assiduously than pay by the day. It is Labour that has opposed piecework, premium bonus and profit sharing plans. It has its own ideas why these things are bad. It looks askance on factories—like some of the motor car factories—where they are regularly employed and where, in consequence, the workpeople enjoy exceptionally high wages. It wants more money, but as a matter of fact it, we mean Labour with a capital L, opposes those methods which would give it what it desires. Our author tells us that the workers may be asked for a "change of attitude." We can assure him that it is that change of attitude which is at the root of the whole matter. The employers with few exceptions desire to adopt modern methods and modern systems; it is because the unions have opposed them that they have been so long delayed. If Labour will put its hand in the hand of the employer and will say "We will help you in every way to reduce the costs of production," then we

do not hesitate to say that wages will go up rapidly, the selling cost will go down, the market will improve, and, political movements apart, peace will be restored to industry.

High-pressure Cables.

THE Institution of Electrical Engineers is to be congratulated upon its policy of encouraging foreign engineers to read papers at its meetings. In these days of rapid electrical development nothing is more desirable or beneficial than an interchange of ideas between those engaged in electrical work in different countries. Since the opening of the Institution's new session in October two continental engineers have contributed material which can scarcely fail to prove useful to those connected with British electrical undertakings. Dr. Ekström's lecture on "Rural Electrification in Sweden," to which we referred in our issue of November 26th, was quite in conformity with present-day requirements, for few technical matters have claimed more attention of late than the question of electrifying the rural parts of this country. Similarly, Colonel Mercier's paper on "The 60,000-Volt Underground Network of the Union D'Electricité," read before the Institution on Thursday, December 16th, and published in abstract on another page of this issue, deals with a subject of no small importance to those who have to grapple with this country's electricity supply problems. Where overhead lines are not permissible and where high pressures are essential, cables such as those described by Colonel Mercier may have to be employed. Although there will doubtless be large areas over which transmission lines may be run, high-pressure cables may often have to be used. The transmission of large quantities of power by means of cables is constantly becoming of greater importance in many parts of the world. It arises, for instance, when it is desired to take high-pressure current through a densely populated area or when it is necessary to connect a high-pressure overhead line to a sub-station situated in a town. Sometimes it is also met with in the outskirts of a rapidly growing town, where the change from an overhead line to a cable becomes necessary. Major A. M. Taylor has pointed out that if underground cables could be worked at the pressures applied to overhead lines it might be possible to obtain wayleaves over the existing tracks of railways.

There appears to be some diversity of opinion among British engineers as to what the maximum pressure is likely to be in this country. Some seem to be under the impression that a pressure of 33,000 volts should in all cases suffice, but it has already been found desirable to adopt a much higher pressure, as, for example, on the North-East Coast. During the period covered by the recently issued Electricity Commissioners' report, *i.e.*, April, 1925–April, 1926, sixteen of the "consents" to erect transmission lines related to 33,000-volt lines and one to 66,000-volt lines, the undertakers in the latter case being the Newcastle-upon-Tyne Electric Supply Company. The need for 66,000-volt cables and perhaps considerably higher pressure cables in parts where overhead lines are impracticable or undesirable therefore seems highly probable. With the widespread distribution systems of the present and the even more extensive systems in contemplation the economy of using larger feeder capacities has become evident; hence the necessity for higher pressures. Apart altogether from this country's requirements, however, British cable manufacturers must not overlook the requirements of other countries in which considerably higher pressure cables than those commonly constructed may be needed to connect up with overhead lines without transformation. There appears to be little doubt that for pressures of 60,000 volts and upwards three single-core lead-covered cables will generally be used, unless, of course, new developments take place in the design of three-core cables. At least two speakers who took part in the discussion on Colonel Mercier's paper, and who ought to know something about the matter, expressed the opinion that for pressures in the neighbourhood of 60,000 volts the ordinary three-core cable is impracticable. For 60,000 volts special three-core cables have been developed, but, judging from the experience of the Union d'Electricité, they have little to recommend them. After carefully examining the construction of 60,000-volt three-core cables manufactured by the best-known firms of various countries and the junction boxes required for such cables, the engineers of the company came to the conclusion that it would be better to employ the single-core type of cable for the extensions to its network. From the point of view of reliability, initial cost and facility for repairs, the system that has been adopted shows up to the best advantage, the increase in the loss in the lead sheath apparently being negligible. These opinions, based on four years' practical experience, should prove of considerable interest to British engineers who may have to lay 60,000-volt cables in the future. Differences in conditions in different countries, such as cost of labour, &c., must, of course, be taken into account; but the most important item of all is reliability, which the single-core cable system apparently gives. Whilst British-made cables have long been recognised to be the best obtainable, English manufacturers and power station engineers alike cannot afford to ignore the recent practice of foreign engineers. The manufacture of continental high-pressure cables is said to have reached a point at which three-phase transmission at 130,000 volts over three single conductor cables is a practical proposition.

At the time the Union d'Electricité decided to apply a pressure of 60,000 volts to its underground network that pressure was considered to be extremely high for cables, and the engineers who were responsible for the scheme deserve great credit for the courage they displayed in adopting it. No doubt, however, in due course 60,000-volt and higher pressure underground systems will become common, for, apart from the saving of space in streets, which is often a matter of considerable importance, the great advantage of high-pressure cables is the possibility of using them in conjunction with transmission lines without transformation. All things considered, the Institution of Electrical Engineers has been fortunate in securing Colonel Mercier's paper, which is written on thoroughly practical lines, its only fault being that it does not describe the difficulties that were met with and how they were overcome.

Corrugated Rails.

IN a recent issue our contemporary, *Le Génie Civil*, published an article written by Monsieur Charles Fremont on the subject of undulatory wear in rails, which he has been engaged in studying by somewhat novel methods.

Monsieur Fremont commences by saying that this question has for a long time occupied the attention of engineers and quotes an article which appeared in our issue of December 2nd, 1904, and which was written by Mr. H. L. Wilkinson, resident engineer of the Bengal and North-Western Railway, on some investigations that he had carried out on lines in India. Since that time, Monsieur Fremont goes on to say, many facts, more or less well attested, have been brought to notice; many explanations of the phenomenon, often contradictory, have been given; and many hypotheses have been formulated, but, generally, experimental study of the matter has been allowed to languish. He then proceeds to give particulars of some investigations relative to wear by abrasion which he began in 1920, and we summarise his remarks in the following.

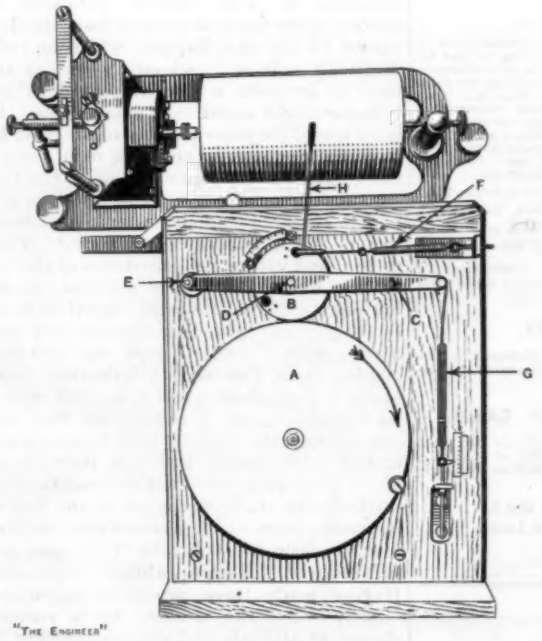


FIG. 1—SHOCK RECORDING INSTRUMENT

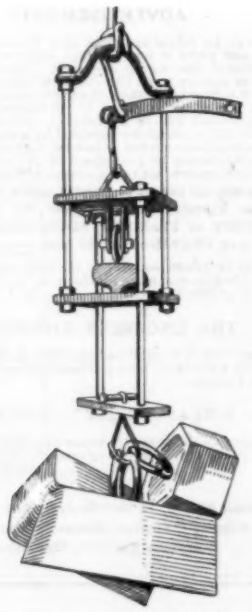


FIG. 2—HARDNESS TESTING

When, remarks Monsieur Fremont, slipping quickly follows rolling motion, a tangential shock is imparted to the wheel in consequence of the sudden and considerable friction set up. This shock is not capable of being balanced by an opposing force; it is a quantity of energy which is absorbed by an elastic deformation of the various members connected to the wheel—generally by a twisting of the axle. This elastic deformation, which is proportional to the intensity of the shock, stores up a quantity of energy, which, when it is suddenly released, tends to make the wheel revolve in the reverse direction, and that, in its turn, produces a local grinding effect between the wheel and the rail at the point of contact. Fresh shocks caused by similar means follow the first shock, with the result that undulations are formed on the surface of the rails, in consequence of the rapidly succeeding jerks.

To illustrate the effect of this tangential shock on the wheels of a vehicle, the apparatus shown in Fig. 1 was designed. In it, it is the rail that is movable and the wheel that remains stationary. The rail, so that it may have a sufficiently rapid continuous movement, is replaced by a disc A of large diameter, mounted on an axle and furnished with a handle by which it can be revolved. The wheel is represented by another and smaller disc B, which is arranged to come vertically above the disc A, the rims of disc and wheel being in contact. So as to be able to vary the weight of the wheel, or, in other words, to vary the pressure between it and the disc, the wheel is pivoted at D to the lever C, which is itself pivoted at E, and which has at its other end an adjustable spring G. When the disc A is revolved by its handle, clockwise, the disc B, which is pressed against it by this spring, tends to revolve on its axis in the opposite direction, but its motion is restrained by another adjustable spring F, one end of which is attached to the disc B tangentially. When the pressure between A and B is relatively slight, and when the speed of revolution of the rail—or, in other words, of the disc A—is low, the sliding friction between the two discs has only the effect of extending the spring F. The amount of extension of the spring remains constant as long as the pressure of the wheel on the rail—or of the disc B on the disc A—and the speed do not change. If, however, the weight and speed be gradually increased, the friction and the slipping increase also, and the wheel still further extends the spring F, the effort to extend the spring being constant and proportional to the friction set up by the slipping.

A time comes, however, when the weight of the wheel and the speed of revolution having been gradually increased, the friction becomes discontinuous, and tangential shocks are set up that suddenly stretch the spring F, which, in its turn, returns to its original tension more rapidly.

A stylus H, mounted radially on the wheel B, traces, on the revolving drum of a recording apparatus, the oscillations of the wheel produced by these tangential shocks, which are one of the causes of the abrasion tending to bring about undulatory wear of the rail.

Abrasion is, however, not the only factor tending to produce corrugation, for in certain cases there may be observed, on the working surface of the rail, a spreading of the metal, with, as a result, the formation of lateral burrs or bulges, which indicate local crushing. Micrographic examination has shown that it is local crushing, for whereas a section of the rail taken through the crest of one of the undulations revealed the fact that the grain of the steel was not sensibly distorted at the surface of the rail, a section taken

through a depression exhibited much breaking up of the grain at the surface and showed a lateral movement of the grains which is not observable in cases of wear by abrasion.

In becoming deformed at the wearing surface, the hardness of the steel is increased locally. It was therefore decided to investigate the importance attaching to this hardneing as a function of the thickness of metal affected, and its influence on the resistance of the rail. To estimate the hardness, at any rate approximately, the indentations made by a hardened wheel, 60 mm. in diameter, with its periphery shaped to a right angle, and acting under a weight of 50 kilos.—see Fig. 2—were measured. These indentations, made at depths of successive one-hundredths of a millimetre from the rolling surface, enabled the relative hardness of the layer of metal affected at different depths to be ascertained. A curve reproduced in the article from which we are quoting showed graphically the results arrived at regarding the hardness of a rail, the original breaking stress of which was 75 kilos. per square millimetre, or about 47·6 tons per square inch.

This rail had worn normally to a depth of several millimetres, and was not splayed or burred. In the curve it was observable that the depth to which the metal was affected was barely 0·14 mm., and that at the surface the work-hardening of the metal had the effect of increasing the tensile strength of the metal to an extent corresponding to a breaking stress of 115 kilos. per square millimetre, or, say, 73 tons per square inch. With a rail of softer steel, with the surface burred or splayed, the hardening has been found to penetrate to a depth of 0·23 mm.

Monsieur Fremont points out that the ultimate strength of the steel, based on the area at fracture, has a bearing on the resistance to wear of the rails. He insists on the necessity for employing photography in investigations of this character, not only for the study of local deformation in the undulations, but also to ascertain the various shapes taken by those undulations, their unequal distribution, &c. To illustrate his point, he gives reproductions of three photographs of rails with undulations on them. In the first case the distance between the crests of the undulations varies between 63 mm. and 100 mm., with a mean of 81 mm.; in the second, the variation is from 75 mm. to 110 mm., the mean being 94 mm.; while in the third, it is from 42 mm. to 85 mm., with a mean of 63 mm.

There is also, he continues, a point on which it is absolutely necessary to have information in order to study these undulations. It is the distribution of the effort of pressure on the rolling surface when the wheel of a vehicle passes over it. For this purpose he has introduced the following method. Having chosen the spot he wishes to investigate, he places on the rail a sheet of paper held in a metal clip furnished with a long handle, and allows a tramcar travelling at a known speed to pass over it. Some dexterity is necessary, for it is essential that the paper must be withdrawn when only one wheel has passed over it. From the marks made on the paper, he observes the local distribution of the effort of compression of the wheel on the rail, and ascertains—within limits, as he observes—the variation of the intensity of that effort. As a matter of fact, the higher the pressure per unit of surface the more the paper is destroyed, and the whole becomes a transparency from which a photographic print may be obtained. This method of recording the pressures between wheel and rail is said to be of great exactitude, and also to reveal defects in the surface of the rail such as small blisters and the striæ made by the friction of the wheels. The application of this new method of investigation has already thrown light on certain phenomena of rail deformation, and it is hoped that by carrying out new trials under conditions which it has been decided to make, all the causes of rail corrugation will be ascertained.

Literature.

Marine Works. By ERNEST LATHAM, M. Inst. C.E. London: Crosby Lockwood and Son. Second edition. 1926. 16s. net.

THIS volume is a collection of miscellaneous papers on various aspects of marine works construction, which, for the most part, have already been published in technical journals during the past ten years. These papers, which deal with a variety of matters more or less related, such as survey of collision damage, pile driving, the conservancy and protection of marsh lands, coast erosion and defence, dredging and the design of river jetties, have been thrown together in a somewhat haphazard fashion, and one result is that several subjects are treated in more or less identical terms in two and sometimes three places in the volume. For instance, the author refers at some length to the measurement of dredging quantities in the chapter on dredging and land reclamation, and, in a separate chapter on quays and jetties, we find nearly three pages of similar matter. Separate chapters on coast erosion and coast defence are full of examples of overlapping and repetition, while references to groynes, sea walls and other sea-defences are found scattered throughout the book. Perhaps the two most useful sections are those dealing with collision damage and its survey and repair, and that on deep water river wharves and jetties. In these, mixed up with material which has little or no bearing on the subjects of the author's papers, is a good deal of sound criticism inspired by practical knowledge, but we fail to see why the author should include under the heading "Salvage of Maritime Works," long paragraphs dealing with harbour improvements and the cost of construction of new sea walls and groynes.

We have noticed several examples of incorrect statement which may be due either to careless use of information or to inefficient proof revision, but in the second edition of a work such as this, it is unfortunate that mistakes of this description have not been eliminated. As an example, on page 204, Mr. Latham credits the former chief engineer of the Port of London Authority with the statement that the total working cost of dredging in the river Thames and depositing at "Black Deep," approximately 66 miles below London Bridge, was about ¼d. per cubic yard. If this were an isolated error it would be natural to put it down as a misprint, but we find the same glaring mistake in two other places in the volume; and on page 186 we read:—"The author has dealt with dredging costs since the war, and these have varied as much as 10s. 6d. per cubic yard in hard chalk to as low as ¼th of a 1d. per cubic yard in clay and mud." As a matter of fact, the total working cost of dredging in the river Thames and depositing at the "Black Deep" in 1921, the year referred to, was, we believe, approximately 1s. 8d. per cubic yard.

The author has a good deal to say about the measurement of dredging quantities, and suggests certain formulæ for ascertaining the actual volume or weight of solid material in a hopper barge. These formulæ are not easy to follow, and in practice would, we think, be of small value. By far the most satisfactory method of measuring dredged material is, wherever it is practicable, by sectioning the dredged area. If barge measurement must be used it is not a difficult matter to construct a scale of mean draughts for each particular barge in use which will give the net weight of the solid material carried within fairly close limits.

The chapter on "Legal Aspects of Maritime Engineering" is not treated so adequately and carefully as the subject demands. A much better synopsis of the law relating to foreshores may be found in the Report of the Royal Commission on Coast Erosion, 1911. Mr. Latham's note contains several errors, such as the statement that "Proposed works submitted for approval to the Board of Trade are referred by the latter department to the Ministry of Health." This is not a normal procedure, and such references occur only in special cases.

The diagram of river tides on page 125 is, we think, to say the least, misleading. We do not know of any river whose normal water level at the upper limit of the tidal compartment is midway between the levels of high and low water at the river mouth.

It is interesting to learn that Mr. Latham, as a result of his experience of river structures, has come to the conclusion that reinforced concrete under post-war conditions is not always the most suitable type of construction to employ for deep-water tidal berths. He finds very little difference in initial cost as between reinforced concrete and composite timber and steel construction. But in regard to maintenance, particularly in cases such as the large majority of river wharf and jetty works, where the risk of collision damage is considerable, he finds decided advantages in favour of timber construction. His notes on this subject, which are scattered in various sections of the volume, appear to us to be based on sound premises and are of value. The examples of collision damage, most of which are illustrated by drawings or photographs, are both interesting and instructive.

Books of Reference.

"INTERNATIONAL Register of Telegraphic and Trade Addresses, with which are Incorporated the Marconi International Directory of Cable Addresses and Code Users of the World, 1926–1927." Published jointly by the Marconi International Code Company, Ltd., Marconi House, London, W.C. 2, and Telegraphic Cable and Radio Registrations Inc., 280, Broadway, New York, U.S.A. Price 27s. 6d.—This new edition of the International Register is a volume of considerable dimensions, and it weighs 11½ lb. It is divided into four main sections: Alphabetical, Travel, Classified Trades, and Cable Signature Sections. There are over 2000 pages of matter, and the volume appears likely to prove of even greater value as a book of reference than those bearing the name of "International" which have preceded it.

"WHITAKER'S Almanack, 1927." By Joseph Whitaker. London: J. Whitaker and Sons, Ltd., 12, Warwick-lane, E.C. 4. Price 6s. net. Abridged edition, 1s. 6d.—We have received the fifty-ninth annual volume of the complete Whitaker. This year's issue has been entirely rearranged, and so far as we have been able to test it, the change is for the better. There is a large amount of revision necessary in the production of a volume of this description, but the work appears to have been efficiently done. The features which have become so identified with the name of Whitaker remain, and we notice that a new article, which gives details of the meteorological conditions during the harvest time and the holiday months for the past fifty-one years has been inserted. The abridged edition contains an abridgment of the complete edition, and is not merely a portion of the whole. The index is very full in both books, cross references being freely resorted to.

"MANUAL of Electrical Undertakings and Directory of Officials, 1925–26." Compiled originally under the direction of Emile Garcke, M.I.E.E. Editor since 1918 F. C. Garrett. London: Electrical Press, Ltd., 13-16, Fisher-street, Southampton-row, W.C. 1. Price 35s. net.—Volume XXIX. of "Garcke" has just been issued. The manual is too well known to call for an extensive introduction, but we may say that it deals exhaustively with every branch of the electrical industry, and is a recognised authority for all financial, commercial and technical information relating to the electrical undertakings of the United Kingdom and the British Dominions and Possessions. The present edition contains full particulars of over three thousand undertakings, and the directory sections contain the names and addresses of over twenty thousand officials, which includes directors, secretaries, managers, engineers, contractors, chairmen and members of municipal committees and others engaged in the industry.

"THE 'Express' Metric Quotation Reckoner." By J. Gall Inglis. London: Gall and Inglis, 31, Henrietta-street, W.C. 2. Price 2s. 6d.—This little volume is intended to enable merchants who deal in the British units to ascertain the equivalent price per metre, kilo, and tonne when estimating. The figures are very clear, and work will be expedited by its use.

"THE South American Handbook, 1927." Edited by J. A. Hunter. London: South American Publications, Ltd., Atlantic House, Moorgate, E.C. 2. Price 2s. 6d.—This book is a guide to the countries and resources of Latin-America, inclusive of South and Central America, Mexico, and Cuba. The resources and possibilities of the countries to the prospective traveller, settler, and merchant are explained and much historical information had been incorporated. An excellent map is included in the volume.

"THE 'Practical Engineer' Mechanical Pocket-book and Diary, 1927." Edited by Ernest G. Beck. London: Oxford University Press. Price 2s. 6d.—This useful little book is now in its thirty-ninth year of issue. The whole of the matter has been carefully revised and brought up to date. It has a buyers' guide, together with technical dictionaries in French, Spanish and Russian. A considerable amount of new matter has been introduced into this new edition.

"THE 'Practical Engineer' Electrical Pocket-book and Diary for 1927." Edited by Conrad Arnold. London: Oxford University Press. Price 2s. 6d.—In addition to having been thoroughly revised and brought up to date, much novel matter has been added to form this year's volume. The section on mining has been rewritten by Mr. R. M. Chalmers, of Wigan Mining College, so as to explain the latest practice in this branch of industry. The book, which is now in its twenty-eighth year of issue, has a buyers' guide and technical dictionaries in French, Spanish, and Russian, together with a good index.

SIXTY YEARS AGO.

OUR issue of December 21st, 1866, had to record "one of the most terrible and disastrous colliery explosions within the memory of any living man." In February, 1857, an explosion at the Lundhill Colliery, South Yorkshire, led to the loss of 189 lives, and in 1862 a terrible calamity at the New Hartley Colliery, Newcastle, caused 219 deaths. But on Wednesday, December 12th, 1866, an explosion occurred at the Oaks Colliery near Barnsley, South Yorkshire, which outstripped all previous accidents in the number of victims. The explosion occurred at 1 p.m., when some four hundred men and boys were at work in the mine. It shook the whole neighbourhood as if by an earthquake and was accompanied by a terrific roar as of distant thunder. For five minutes black smoke poured up from the downcasts and then suddenly ceased. At about 2 p.m. volunteers descended the pit and throughout the afternoon and night succeeded in recovering about eighty of the victims, of whom eighteen were alive. It was not the first explosion at the pit. On March 5th, 1847, a disaster had occurred which caused a loss of seventy-three lives. Nor was it the last, as the rescuing parties were speedily to discover. A second explosion was, it seems, foreseen by the rescuers, and shortly before 9 a.m. on the Thursday morning the majority of them were ordered to return to the surface. About twelve remained behind, when a second explosion, said to have been even more violent than the first, occurred. All the rescuers remaining in the pit perished. At 9.50 a.m. a third explosion occurred. Dense white smoke and sparks ascended from the shafts until about 1 a.m. on Friday morning. Shortly before 5 a.m. those at the pit bank heard the signal bell ring. Two men decided to descend and when they reached the bottom they found a man alive and brought him to the surface. Whether this man was one of the earlier rescue parties or whether he was one of the miners at work when the first explosion occurred is not stated. His two rescuers saw signs that many acres of coal were on fire. For some time afterwards the cage was lowered repeatedly and allowed to stay at the bottom for a few minutes each time, but no further lives were saved. Fresh explosions took place during the Friday evening and on Saturday, Sunday and Monday, fifteen in all, gradually decreasing in intensity, being recorded. The fire was eventually overcome by filling up the shafts with spoil to exclude air from the workings. The pit, it was stated in our report, was completely destroyed. The disaster, it was currently believed, was caused by heavy blasting operations, which ignited the gas. Modern investigations would lead us strongly towards the view that it was a coal dust explosion or, at any rate, that coal dust was the chief factor in propagating the explosion after it had been initiated.

A Shale Planer.

THERE has recently been put to work in the Peterborough brick-making district a decidedly peculiar machine, that embodies the two great merits of cheapening production and eliminating an occupation which has hitherto been rather hazardous to the workmen. This machine, of which we give some illustrations herewith, is employed in excavating shale from the local deposits for the manufacture of bricks, and we were fortunate enough recently to explore its working qualities under what were described as the worst climatic conditions that have existed since it was put into operation.

The brick-making shale of Peterborough is a homogeneous deposit of fifty, or more, feet depth overlaid with gravel and soil to a depth of, say, 12ft. It has been the practice in the past to remove the overburden and then break away the shale by manual labour, allowing it to fall down into the bottom of the excavation, where it was shovelled into trucks to be taken away to the brick-making machines. The work of winning this shale has been laborious, as it is nearly of the consistency of slate, and required considerable muscular effort on the part of the men, while slips caused by wet weather or the exposure of faults in the deposit were a menace to the safety of the excavators and loaders alike. The machine which we have under consideration has not only eliminated those risks to the employees, but it has also increased the output of shale, so that the production of bricks may be brought up to the requirements of present building programmes.

A machine for such a purpose as we have just outlined is, of course, of a special character, and may be, as it stands, only applicable to the local conditions for which it was designed; but there is evidence that it may have a fairly extended application, as our investigations have already discovered one machine at work and two others in course of erection in the works of the makers, Ruston and Hornsby Ltd., at Lincoln. The machine which we illustrate in the half-tone engravings is that which we saw at work near Peterborough, and it is working on a face some 50ft. high, while the machine shown in the line drawing is one of those which we examined in the Lincoln shops, and is to cut an 88ft. face. It is, of course, impracticable to erect completely a machine of such dimensions under cover,

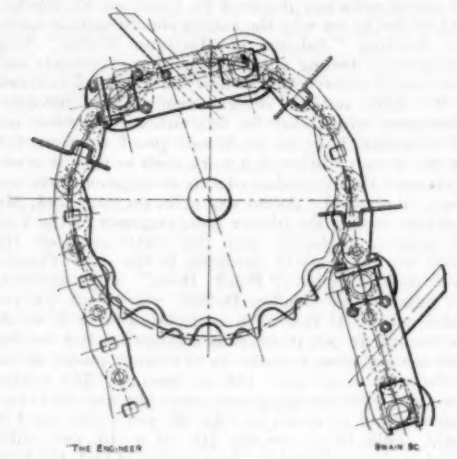


FIG. 1—CHAIN SPROCKET

and on the occasion of our visit to Lincoln it was only possible to study the structure up to the level of the working platform, and that was well up in the roof of a tall erecting shop. Above that level there is the comparatively simple structure which carries the excavating chain to the upper limit.

Before, however, we describe the new and larger machines, it may be as well to give some impression of our experiences in studying the pioneer machine at Peterborough.

This machine, or "shale planer," as it has been named, is working in a pit where there is an overburden of, say, 12ft., which is removed by a Ruston steam navvy, and is trammed away to the back of the main excavation. The shale deposit has almost level top and bottom partings, and is from 50ft. to 55ft. deep. It will stand with an almost vertical face, but, on weathering, crumbles away. In dry weather the shale is easily handled, but after rain, as was our experience, the material produces the most tenacious mud imaginable. On the other hand, the shale has the merit that it is of such a consistency that it can be sent straight to the brick-making machines without the admixture of any water or other ingredient.

It will be readily understood that the handling of such a material by a continuously running machine is no easy matter, and we feel that the manufacturers are to be congratulated on the success of their enterprise.

On first viewing the machine one of the things that struck us most forcibly was the fact that it seemed to be "going the wrong way round." That is to say, the excavating chain was cutting down the face of the quarry, instead of cutting upward, as is the case with most excavators; but a brief investigation showed the reasonableness of the system. For one thing, the frame carrying the chain must obviously be overhung from its supporting carriage, and is of a considerable weight. This weight would be augmented by the reaction of an upward cut, but is actually relieved by cutting downward. Again, it is the custom to tram the shale away from the bottom of the excavation, as that generally provides the most direct route back to the brick-making plant, and, as a consequence, upward cutting would involve more work against the action of gravity; but whatever theories may be put forward on the subject, it has been found best, by practice, to cut downward.

The cutting is performed by a series of teeth attached to a continuously moving chain, which is guided down the face of the quarry by a frame. The arrangement is, however, peculiar in that there is only one tooth on each toothed link of the chain, and this tooth is arranged at the centre.

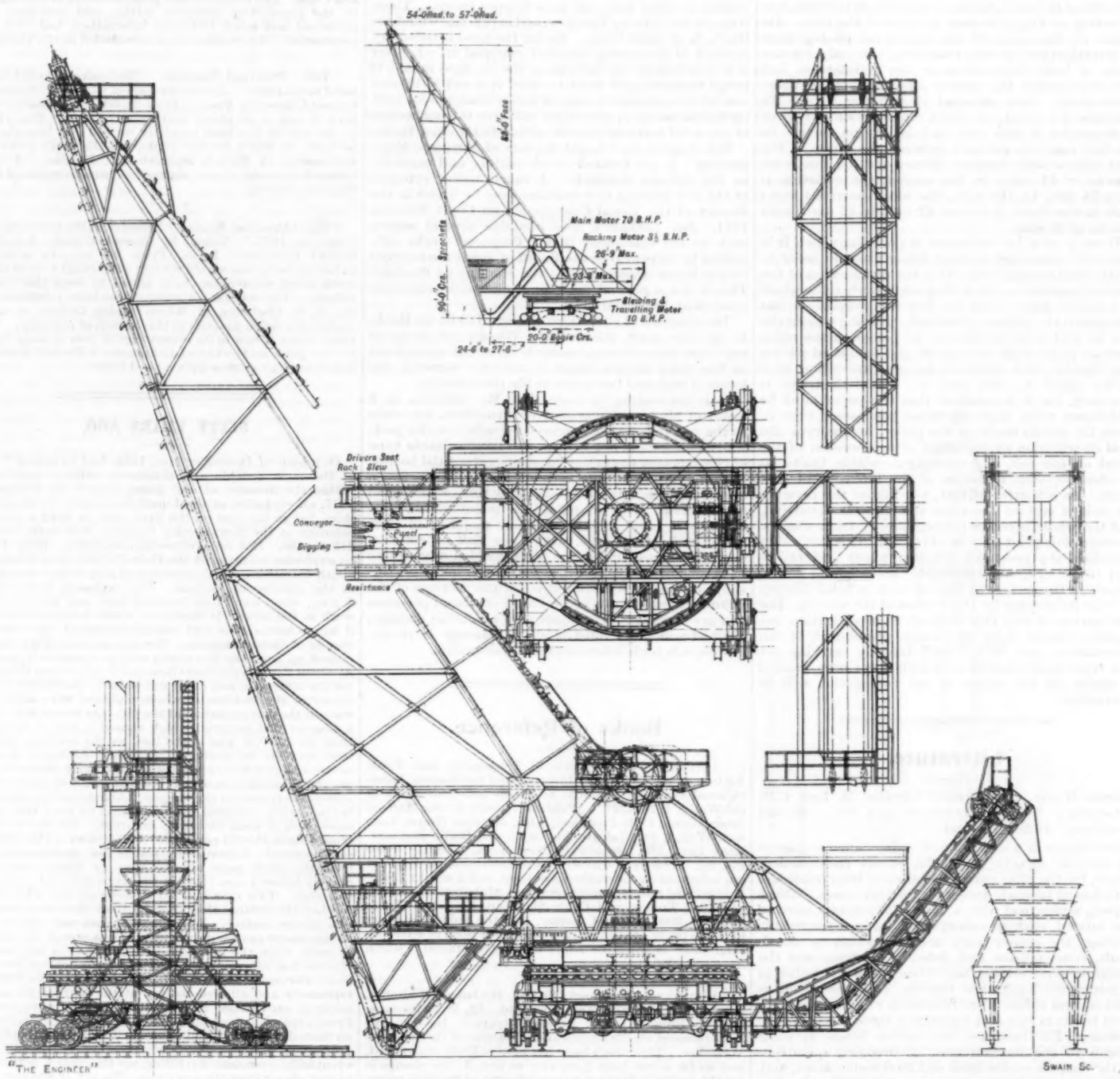


FIG. 2—SHALE PLANER FOR 88ft. WORKING FACE

The total width of the chain may, nevertheless, be as much as 3ft. 9in.—as is the case in the machine shown in the line drawings. Between the successive cutting teeth there is fixed a series of scraper plates, but they do not extend outward so far as the teeth. The arrangement may be followed with the aid of Fig. 1, which shows the chain going over the upper sprocket, and which has been primarily prepared to illustrate another peculiarity of the chain, that will be referred to directly.

The whole assembly of chain, teeth and scraper plates works inside a casing with an open side facing the quarry face, and each tooth tears off the shale, to a depth of, say, ¾in., so that it drops on to the scraper plate below. As the cut progresses the whole framing is continuously rotated about an axis on the main carriage, and the consequence is that each tooth arriving at the top of the journey down the cliff face has new material to work upon. The shale is fairly brittle, and the consequence is that each tooth breaks off sufficient material to load up the scraper plate below it.

At the bottom of the frame there is a sprocket under which the chain passes towards the delivery point. This second section of the conveyor runs in a steel trough, and the transition from one part to the other takes place over the natural ground. Each charge is left by the plate that has carried it down the face on the ground at the bottom of the pit, and is then overtaken by the succeeding plate, which carries it up the trough to the discharge shoot. As a consequence of this arrangement there is a small accumulation of *débris* at the foot of the face, and a man is stationed there to shovel this shale on to the rising side of the conveyor. He is protected from stuff falling down the face by a roof that itself tends to guide spillage towards the conveyor. (This roofing was dismantled when the photographs for our half-tone engravings were taken.)

Reverting to Fig. 1, it will be noticed that the links of the chain are of a rather special formation, for the following reason. In order to get as smooth an action, as possible, of the chain riding over the sprockets its links are comparatively short—9in.; but such a base would not give sufficient stability to the cutting teeth. The teeth are, consequently, fixed in frames which span two links and get a correspondingly extended foundation. The result is that on passing over the sprockets the tooth links take up a mean position inside that of the carrying links and work round a shorter radius. The necessary accommodation is provided by arranging a sliding bearing at one end of each tooth link, as shown in Fig. 1. It would appear, at first sight, that an arrangement of this form might give trouble in such service as that of a clay pit; but when we inspected the machine, and the conditions were, as we have said, such that it was "clarted up" with sticky mud, the planer still continued in operation without any apparent extra effort.

The shale carried up the rising leg of the elevator is dumped into a shoot at the pivot centre of the machine, and, in the case of the machine we saw at work, drops down into a tipping truck below.

This part of the operation, also, may be pointed out as emphasising the difficult conditions under which the machine was working. A short halt had to be made, with the shoot full, for the arrival of a train of trucks and, in the interval the charge of cut shale became so consolidated that it was necessary to beat the shoot heavily with a large hammer to dislodge the charge. We imagine, however, that in reasonably dry weather no trouble of this kind would occur.

After the main structure and revolving frame have slewed right across the semi-circular cut, the slewing motion is reversed, and the main structure is racked forward the required amount of, say, ¾in. This slow semi-rotary motion is continuous, the main structure being swept across the face alternately one way and then the other, and at the same time being fed in at the proper intervals until the limit of "Racking," as this feed is called, is reached.

It is then necessary to travel the whole machine forward. The first operation is the "racking back" of the main structure the full distance of the racking motion, while the rails are being laid on sleepers in front of machine. The whole machine is then travelled forward until the cutters again engage the face of the cut. The rail wheels are then chocked to the rails, the travelling gear is put out of action, and the slewing gear is started.

The slewing and racking motions are then operated as described above, until the main structure has again been fed forward the maximum amount, when the machine as a whole must be travelled forward again; this cycle of operations is constantly repeated.

It will be noticed that the driver's cabin is arranged close up against the cutting part of the chain, where the man has a good view of all the operations, and has all the necessary controls within reach, except the clutch for putting the travelling wheels in operation. The lever for this purpose is worked from the ground level, but only requires occasional operation. The whole crew of the machine, exclusive of those employed in tramming away the shale, is three men. The machine at the Peterborough brickworks is run by alternating current, supplied by a long length of flexible cable, connected with the control apparatus in the operator's cabin by means of collector rings arranged round the centre shoot of the machine.

For the purpose of explaining the structural details we will now go on to the larger machine, which we saw in course of erection in the Lincoln shops.

It will be noticed from the line drawing—Fig. 2—that the loading arrangements are different from those of the machine just described; in all other respects the principle of the two units is similar. The difference arises from the fact that it was thought best to keep the centre of gravity as low as possible, which meant that the trucks could not be brought underneath the main frame. So the cut shale is dropped down a funnel on to an auxiliary conveyor, which delivers it into a portable hopper, under which the trucks are run. This conveyor can be arranged to project from either side or at the back of the main frame.

As already mentioned, the machine is intended to cut an 88ft. face, measured vertically, but it will actually cut a little more, as the top and bottom chain sprockets are set 90ft. apart vertically. The batter of the face, as cut, is 1 in 2·94. The output of the machine is 110 cubic yards of shale in the excavated condition per hour, when working on an 88ft. face. To get this output the cutting chain is run at a speed of 140ft. per minute.

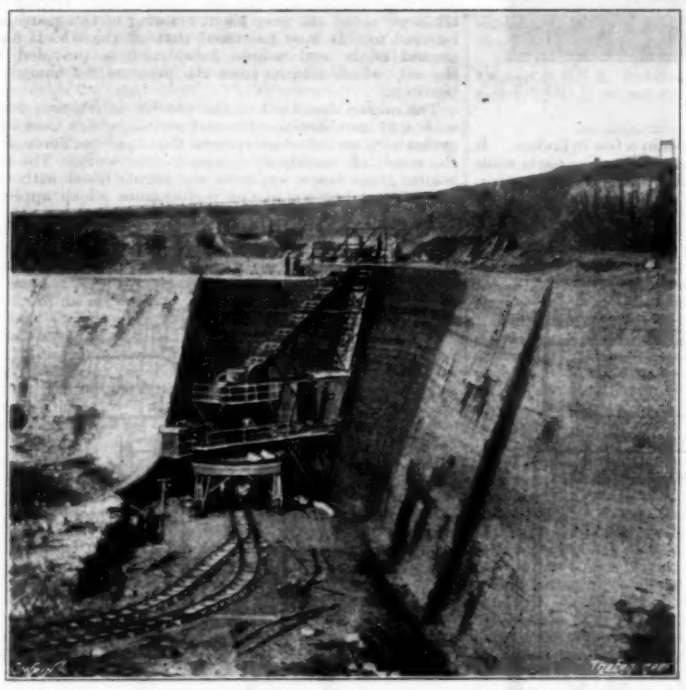
The weight of the whole machine is carried by four four-wheeled bogies running on 100 lb. standard railway metals. The bogies are at the corners of a square of 20ft., and the pairs of rails are spaced 2ft. 10½in. apart. In order to equalise the load on the several bogies a rather unusual system of levers has been adopted, principally with the object of economising height. As will be seen from the general arrangement, two massive bell-crank levers are fixed under each end of the main frame. These levers are pivoted to the frame, and while one arm of each bears on the top of a bogie, the other two arms are tied together by a horizontal rod. The result is that the bogies can rise and fall to accommodate variations in the level of the rails, and still always bear their share of the load.

The bottom frame, on which the whole superstructure is supported, is a built-up structure of rolled joists, and some idea of its massiveness may be gathered from the fact that, when standing on the rail level, a tall man can only just scan across its top surface. The framing is open in the centre, to accommodate the funnel down which the cut shale is dropped, and beneath it there is arranged the gear for travelling the machine along the rails and for slewing it about its centre. In travelling, the machine is capable of surmounting a gradient of 1 in 20 unaided, and has a speed of 6ft. per minute. It takes half an hour to slew the machine through a complete circle. Both these movements are actuated by one motor, of 10 horse-power, and either can be put in operation by means of a local clutch. This gear is also so arranged that it can be made to provide accommodation for the discharge conveyor in any one of its three positions. The discharge conveyor, by the way, is worked by an independent motor of 8 horse-power.

The revolving superstructure is supported on a ring of forty-eight rollers, 10in. in diameter, with double flanges. These rollers have cylindrical treads to eliminate the outward thrust of conical rolls, and work between two rings of heavy standard railway metals, 20ft. 4in. in diameter. Above the upper ring there comes a heavy rectangular framing, and then, still higher up, the base of the superstructure.

The whole of the superstructure must be slidable to feed the cutters up to their work, and for that reason runs over rollers fixed to the frame below. At the front end, where the greater part of the load is concentrated, there are two rollers on either side, each pair being mounted on an equalising beam. At the back there are two plain rollers. It will be readily understood that these rollers have to carry a very concentrated load, so the joists are reinforced in their vicinity by steel castings, and machined faces are provided for the rolls to run on. Keeps are also arranged over the top of the moving platform, as a guard against its being overturned. Towards the back of the moving frame there is a rack and pinion gear, operated by a 3½ horse-power motor, for moving the whole superstructure in and out. The forward movement is at the rate of 2in. per minute, but it can be backed out at a speed of 18in. per minute. What might be described as the "squareness" of the superstructure is insured by horizontal bracing which braces the side members against the slewing forces, and which embraces the shale funnel with enough clearance to allow for the racking movement. At the rear there is a counterbalance of 40 tons of kentledge, while at the front, on the same level, there is the operators' cabin, with all the controls, except that already mentioned for changing from slewing to travelling.

The framing carrying the cutting chain needs little description, as its form is obvious in the drawings, but it may be as well to point out that stretch of the chain can be taken up in the sliding bearing at the top. The style of the chain itself is the same as that shown in Fig. 1, and it is 3ft. 9in. wide. The driving motor, which is of 70 horse-power, works the sprocket at the delivery corner of the chain through two sets of spur gearing, and is equipped with a slipping clutch to prevent damage in the event of the chain jamming. This clutch, like that of the other motors, is of the dog type, with sloping working faces held together by a spring. It gives a positive drive so long as the resistance of the spring is not overcome, but, after that point, rides over freely without heating. All the motors on the machine are worked by three-phase current, which is supplied by one trailing cable connected with a socket on the underframe.



FIGS. 3 AND 4—50ft. FACE SHALE PLANER AT WORK IN QUARRY NEAR PETERBOROUGH

The Beardmore "Cyclone" Aircraft Engine.

THE important contributions which have been made by William Beardmore and Co., Ltd., to the design of quick-running internal-combustion engines of light weight and high output are widely known and appreciated. We need hardly refer to the early Beardmore 160 brake horse-power aircraft engine and to the later Puma engine, which have both played an important part in the progress of aircraft machinery design. It will also be recalled that in our issue of October 2nd, 1925, we published a description of the new all-steel quick-running heavy-oil engine, which the firm is constructing for rail car work on the Canadian National Railways. Further particulars concerning the design of this engine were given in a paper on "The High Efficiency Oil Engine," which was read by Mr. Alan E. L. Chorlton, before the Institution of Mechanical Engineers, and was reprinted in our issues of March 26th and April 2nd last. The type of engine then described has certain features in common with the new Beardmore aero-engine, but as most of the aircraft work which is being done by the firm is for the Government Services, it has, for obvious reasons, not been possible, so far, to give an adequate technical description of these new units.

Recently, however, there was completed at the Beard-

more Aero-engine Works, Parkhead, a six-cylinder Cyclone petrol engine designed for a maximum output of 950 brake horse-power. It is to be used abroad, and was tested on behalf of the purchasers, the Ernst Heinkel Flugzeug-

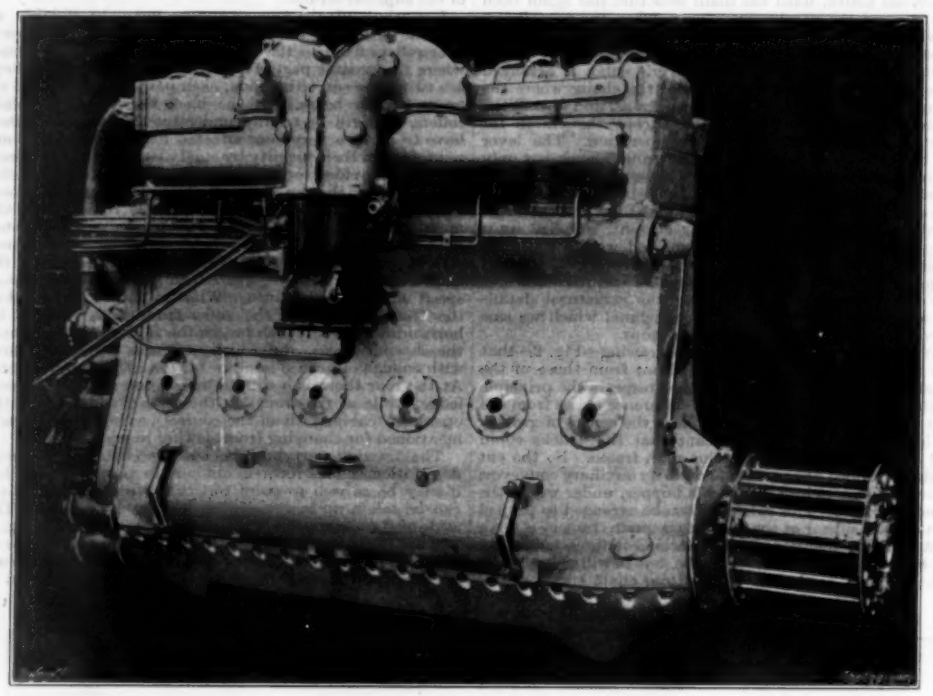


FIG. 1—950 B.H.P. BEARDMORE "CYCLONE" AIRCRAFT ENGINE

werke, Warnemunde, Germany, by Lieutenant-Colonel W. A. Bristow, of 39, Grosvenor-place, Westminster-S.W. 1. By the courtesy of the builders we were invited to be present at the trials, which took place on October 26th. In this article a description of the engine, and a synopsis of the test results will be given, together with some indications of the scope of application which it offers.

Engine Design and Particulars.—A general view of the front side of the Cyclone engine is given in Fig. 1, and it will be seen that the unit is complete with its air screw hub, although that part is not included in the dry engine weight given below. In the elevation and section drawings—Fig. 2—the main features of the design are illustrated. The engine output at varying speeds is given in the accompanying trial results. It has six cylinders, each 8¼in. in diameter, with a piston stroke of 12in., and a designed compression ratio of 5·25 to 1. The overall length of the unit is 80·3in. with a maximum width of 35in., while the overall height is 60·37in., with a total height above the centre line of the crank shaft of 45·25in., and a maximum depth to the lowest point below the crank shaft centre of 15·12in. The dry engine weight, which includes all necessary accessories, but no oil and water, is 2150 lb. The engine is water-cooled and a circulating pump, which is designed to work in conjunction with radiators, is fitted. The ignition system is in duplicate, and two Watford type C.6.8.M. type magnetos are employed. As illustrated, the engine is designed for a left-hand tractor-type propeller running at a normal speed of from 1220 to 1350 revolutions, according to the power it is desired to develop.

In getting out the new design the object in view was to develop as high a power as possible in a few cylinders. It was also sought to reduce the number of engine parts while retaining the maximum accessibility. An outstanding feature of the engine is its compact and clean outline, which enables it to be installed in a very narrow fuselage, thereby reducing considerably the amount of head resistance which would be offered by an engine either of the radial or the vee type. The crank case is made in high grade aluminium and, as shown by Fig. 2, it forms the main engine body. It encloses the crank shaft and its bearings, which are carried on transverse girders, while the cam shaft is accommodated in the top part of the casing. At the level of the crank shaft, the body is swelled out to give great lateral strength to the crank case about the crank shaft, and permit of direct connection to the engine bearers, whilst underneath there is a removable oil sump. Access to the working parts is given by inspection doors, which are fitted to each cylinder, one on either side of the crank case. Cylinder liners of thin steel are inserted into the upper part of the casing, and are supported both at the top face and by a lower ring, which encloses the cooling water space.

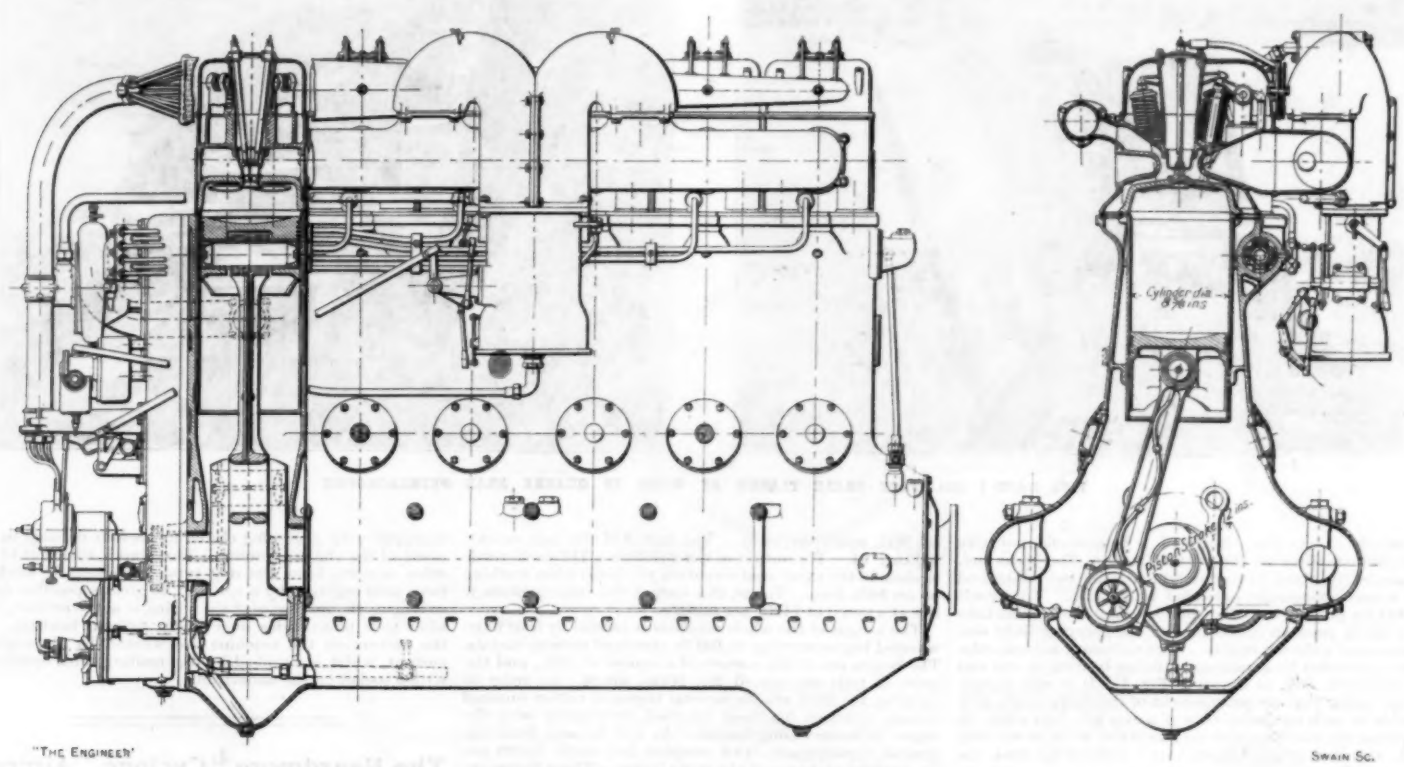


FIG. 2—SECTIONS OF 950 B.H.P. AIRCRAFT ENGINE

It will be seen that the cylinder head and valve gear form a separate unit, which is readily detachable. For each cylinder there are two exhaust and two induction valves which are operated through rocker levers by short push-rods. As shown in the left-hand cylinder section—Fig. 2—twin sparking plugs are fitted in the crown of the cylinder head and are well cooled. The same illustration shows the end gear case enclosing the gear drive from the crank shaft. The cam shaft, it will be seen, is driven by a series of intermediate gears, which in turn are usefully employed to drive various accessories mounted on the end case. This casing, with its attachments, is so designed that it can be removed from the engine in a few minutes whilst each accessory can, when required, be quickly detached. The various auxiliary fittings referred to, include, beside the two magnetos, the lubricating oil pressure and suction pumps, the circulating water and petrol pumps, as well as a gas distributor, and gun gear, when the engine is designed for use in a military machine. At the bottom of the gear case there are duplex lubricating oil filters on both the pressure and suction sides of the oil system. The filters are provided with change-over valves, so that either can be cleaned while the engine is running. Brief reference may be made to the lubricating system. Oil is delivered under pressure to the main bearings, and passes by means of drilled passages to the big ends, after which it is taken up to the gudgeon pins through tubular connections, which are strapped to the webs of the steel connecting-rods. A hollow gudgeon pin, with closed ends, is used. The piston is made of forged and machined aluminium, and is fitted with three piston rings and one scraper ring. During the trials we noted the very silent running of the gears just referred to. It may be stated that all the wheels have ground teeth, and ample lubrication is provided by the oil, which returns from the pressure fed cam shaft bearings.

The engine described in the present article was fitted with a 97 mm. Zenith twin carburetter, which works together with an induction system, that has been evolved as the result of considerable experimental work. The test results given below apply to the engine fitted with this carburetter, but a superior performance which approximates more closely to the standard type of engine is given when a 120 mm. carburetter is fitted.

Test Results.—The three test runs made at different speeds, the results of which are given in the above table, illustrate the fuel economy of this type of engine, especially when it is running at a cruising rating. In order to deter-

Test Results.

Speed, load and power.			Fuel consumption.		Lubricating oil.			Cooling water.		
R.P.M.	Pounds load.	B.H.P.	Average fuel used per hr., gals	Pounds per B.H.P. hour.	Inlet temp., deg. Fah.	Outlet temp., deg. Fah.	Pressure, lb. per sq. in.	Inlet temp., deg. Fah.	Discharge temp., deg. Fah.	Gallons. per min. circulated.
1220	710	722	44·22	0·465	120	148	40	149	160	170
1220	795	808	51	0·48	120	150	40	148	160	170
1350	843	949	63·75	0·512	118	154	40	148	160	184

mine the amount of lubricating oil used, the total oil required was logged over the running period of 6 hours and 10 minutes. During this time, 52·75 lb. of oil were utilised, which is equal to a consumption of ·01 lb. of oil per brake horse-power hour. The lubricating oil corresponded to the Air Ministry specifications P4, and had a specific gravity of 0·895, at a temperature of 60 deg. Fah. A fuel mixture of 80 per cent. Shell aviation spirit and 20 per cent. benzol was used for the test. It had a specific gravity of 0·760 at 60 deg. Fah. The average temperature outside the test house during the trial was 38 deg. Fah., while that at the engine carburetter was about 56 deg. Fah., with a 30in. barometer. In order to supply the load a specially designed Froude water brake was used. The engine was started with ease by means of a Bristol gas starter.

General Applications.—The successful conclusion of the trials of this engine is an event of special interest in connection with the development of engines for modern aircraft. The satisfactory results obtained will, in all probability, lead to the opening up of a new phase in the design of aircraft of large-carrying capacity. Especially does this apply to the design of sea-going aircraft as, hitherto, there has been no power unit of this type available for really large machines.

In the light of the improved performance of this engine it is interesting to pass in review the leading features of some earlier types of aircraft engines. At the outbreak of war we had in the main to depend on supplies from France, the 75 brake horse-power Renault engine being at first imported, though it was afterwards made here. This engine had eight cylinders with a maximum output of 10 brake horse-power per cylinder. Almost immediately there was a considerable step forward, as in January, 1915, the Sunbeam Company produced and delivered a number of 12-cylinder 250 brake horse-power engines with a maximum output per cylinder of about 22 brake horse-power. This engine was followed in June, 1915, by the Rolls Royce Eagle engine of about the same capacity, and for the period of the war there seemed to be a general consensus of opinion that an engine of 12 cylinders, each giving on the average about 25 brake horse-power, was the right kind of motor. The engines designed by Messrs. Beardmore formed, however, an exception to this opinion. Both the 160 brake horse-power engine and the Puma had six cylinders only, and were designed to give full output at such a speed as would allow the propeller to be mounted directly on the crank shaft. The appearance of the Beardmore engine was at first heralded with considerable adverse criticism, as there then were many, even among those well qualified to judge, who did not believe that slow-running engines with ungeared propellers and cylinders of comparatively large size, would ever prove satisfactory power units for aircraft. This was perhaps a rather remarkable view to take if it be borne in mind that practically the whole of the German air force machines were engined with units of this type. Such a view, however, might perhaps be regarded as only natural if it were inspired to some extent by the dislike of following the technical policy of an opponent.

Since the war the general line of progress has again swung back to multi-cylinder type engines, and the number of cylinders has been increased up to fourteen and sixteen, with an output per cylinder of 60 brake horse-power on some of the service type engines with an even higher figure in special cases. With regard to the Beardmore development it is interesting to note that history is, to some extent, repeating itself, for the firm is again coming forward with a six-cylinder ungeared engine which is claimed to be simple and accessible, and in which the cylinder output has been raised to no less than 160 brake horse-power, a figure about sixteen times that of the Service engine of twelve years ago. The power is, moreover, produced at the comparatively low speed of 1350 revolutions per minute instead of 1800 revolutions per minute.

For naval and military purposes it is contended by Messrs. Beardmore that for aircraft with power plant of this output a single engined machine is to be preferred to a machine with two engines. Greater ease of control is given, and there is less lateral moment, with increased ability to hold the machine on an exact course at the moment of releasing a bomb or torpedo. It is clear that the vulnerable area of the power plant, including the controls, tanks, piping, &c., is also much less than would be the case with a twin-engined machine. Some idea of the increase in the load carrying capacity of single-engined machines, which is rendered possible by the production of the Cyclone engine, is given by the fact that it is now possible to design a machine which will carry almost one and a-half tons of bombs or torpedoes together with all the usual military load, such as guns, ammunition, &c., and at the same time carry enough fuel for a radius of action of over 700 miles. Such a machine would have very great advantages, which would all be derived from the inherent features of the engine, chiefly its narrow frontal area, slower speed direct-driven propeller, low fuel consumption, and from the fact that for the first time a 950 brake horse-power unit is produced in simple six-cylinder form.

Fixed Condensers and Ebonite for Radio Reception.

A SPECIFICATION just issued by the British Engineering Standards Association deals with two types of "fixed" condensers, namely, those in insulating cases and those in metal cases, the sizes in each type being confined to those suitable for radio reception purposes.

The types are subdivided according to the nature of the dielectric, the recognised materials being mica and paper. The first subdivision includes condensers normally employed for grid rectification and for shunting the primaries of inter-valve transformers, &c., while the second subdivision includes condensers suitable for shunting across the high-tension terminals and for employment in the construction of units for obtaining a high-tension supply from the lighting mains, &c.

Each type of condenser is standardised in two grades, these grades being based on the closeness of the actual capacity value to the nominal capacity value marked on the case of the condenser. The condensers are therefore referred to as being of "normal" grade or "special" grade, this classification being based on accuracy and not on quality. The electrical properties of the condensers are specified by means of power factor, insulation resistance, and high-voltage tests, and the constancy of capacity is covered by a heat test. The dimensions of the fixing holes are also specified. Beyond this it has been considered inadvisable to attempt the standardisation of dimensions at present.

The aim in the preparation of this specification has been to safeguard the purchaser against unreliable goods, at the same time enabling the condensers to be made at a reasonable price. In cases where the manufacturer holds a licence from the British Engineering Standards Association the trade mark "BESA" may be marked on the condensers to show that they comply with the requirements of the specification.

Copies of this specification may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, S.W. 1, price 1s. 2d. post free.

Ebonite for Panels for Radio Reception.—A specification, issued in November, 1925, contained a list of recommended panel sizes, this list having been drawn up in the light of the normal requirements of constructors as reflected in the articles appearing in the wireless technical periodicals. Since that date the external design of receiving sets has altered somewhat, and the original panel sizes are no longer the most convenient. Furthermore, since the issue of the specification many more manufacturers of ebonite have marketed panels cut to size and sold in sealed envelopes, thus encouraging the demand for standard sizes of panels. In co-operation with the B.E.S.A. the manufacturers of ebonite have revised the list of recommended sizes, and this new list is now incorporated in the specification. The standard thicknesses have been reduced from three to two by the elimination of the $\frac{1}{4}$in. thickness, but the number of standard panels remains in the neighbourhood of twenty. The two sizes of standard strip are retained, these having been found particularly useful for the mounting of terminals at the back of the baseboard.

The specification remains unaltered as regards the composition and testing of the ebonite, and it is interesting to learn that two or three manufacturers have already obtained a licence to use the trade mark "BESA" in connection with their panels.

Copies of the revised list of panel sizes will be forwarded by the B.E.S.A. Publications Department, 28, Victoria-street, S.W. 1, on receipt of stamped envelope.

SILTING IN THE TRURO RIVER.

THE report of Sir John Wolfe Barry and Partners, of Westminster, on the problem provided by the Truro River, which is silting up steadily, has now been presented to the Truro City Council. The report points out that the mud which accumulates annually between Malpas and the City of Truro is estimated at about 15,000 tons, and the quantity removed under the system at present in operation is about 6000 tons. There is thus a surplus accumulation every year of 9000 tons of mud, which as time goes on renders navigation up to Truro more and more difficult. Under the present system of digging the mud when the tide is down, throwing it into barges and then transferring it to the reclamation ground at Boscawen Park, the cost of the labour of four men works out at 2s. 6d. a ton, to which has to be added 2d. a ton on account of the retaining bank and plant. At the present rate of digging it will take ten men filling into five barges to keep pace with the accumulation of mud, and that without any permanent improvement to the river; while it would take about thirty men and fifteen barges to effect any real improvement, such as the removal of shoals and the straightening of the channel so as to cut off the difficult bends, in accordance with the scheme sanctioned by the Provisional Order of 1903. To improve the river would require the removal of 28,500 tons a year, to which must be added the annual accumulation of 15,000 tons, and this total of 43,500 tons a year is seven and a-half times the quantity now being moved by hand labour. The cost of dealing with this total by the same method at 2s. 6d. a ton would be £5800 a year. The engineers, however, recommend the provision of a sea-going self-propelled grab hopper dredger, with a capacity equal to improving the river in about five years to the extent contemplated by the 1903 Provisional Order. This dredger would be fitted with an electric light installation so as to enable it to work at night, and a 150-ton vessel is recommended as the most advantageous to adopt. The capital cost of such a vessel would be about £9500, and the annual working expenses of the scheme, including interest and sinking fund, repairs, maintenance and wages, are estimated at £3060. With such a basis the cost of dredging the 43,500 tons a year would work out at 1s. 4d. per ton of material dredged and dumped at sea, or only half the cost of working and depositing by hand labour. The report remarks that even after the river had been improved to the extent of the Provisional Order, there would be plenty of work to keep the 150-ton dredger profitably employed in still further widening and deepening the river. Although the cost of the scheme would not be covered by the present harbour revenue, it is pointed out, in conclusion, that the revenue is dependent upon adequate facilities being provided at the port, and that by increasing the width and depth of the channel, a larger class and greater number of vessels would be attracted, with a corresponding increase of the harbour revenue and enhanced prosperity for the city's trade.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE SMITHFIELD CLUB SHOW.

SIR,—The references in your last two issues to the "lackadaisical" attitude of British agricultural engineers and the lack of novelty at the Smithfield Show cannot be allowed to pass unchallenged.

It is obvious that the exhibitors show the machinery which they think will make the greatest appeal to the visitors who come to see the Show, but we cannot understand why they should be accused of being "lackadaisical" because the exhibits do not include the novelties that your representative was looking for.

The very instance of novelty that you mention is an excellent example. The "plain straightforward traction engine" is a very familiar exhibit at such Shows, but it presumably satisfies the test applied by the exhibitor, *i.e.*, it is what the customer wants to buy, or at least to inspect and take note of for the future.

Your representative seems to have forgotten that the Show is held for the benefit of English farmers, who, as a whole, are in a far from flourishing condition, and cannot be expected to spend much in machinery at present. They are not likely to be tempted to pay an extra price for the latest up-to-date fittings, when their chief care is to buy only what is absolutely necessary, and then at the lowest possible price consistent with satisfactory service.

The Smithfield Show is one of the minor Shows of the year for the agricultural engineer, the chief being the Royal Agricultural Show in the summer, and the exhibits at Smithfield are also very limited by the space available, so that only one or two of the chief products of any firm can be exhibited at a time.

Your representative, however, goes to the other extreme when, after complaining of the lack of novelties, he dismisses a new implement which had not been exhibited at Smithfield before as unworthy of detailed comment, because "we imagine that many of our readers are not directly interested in agriculture."

It is a little difficult to follow the mentality of one who claims the general-purpose traction engine as a novelty and passes over one of the largest new agricultural implements at the Show as unworthy of notice.

In your issue this week you are kind enough to voice the opinion that the agricultural engineer may be allowed to rank as an engineer, but, if so, surely the machines he builds should be considered of some interest as engineering productions, and not dismissed in a sentence because they belong to the muddy and despised business of agriculture.

Agriculture is universally recognised as the premier industry of the world. For this reason the agricultural engineer who devotes his energies to building of machines to produce heavier crops at reduced cost should have a valid claim to take high rank among engineers instead of having the question raised whether he can be allowed to rank as an engineer at all.

For JOHN FOWLER AND CO. (LEEDS), Ltd.,
CHARLES H. FOWLER, Managing Director.

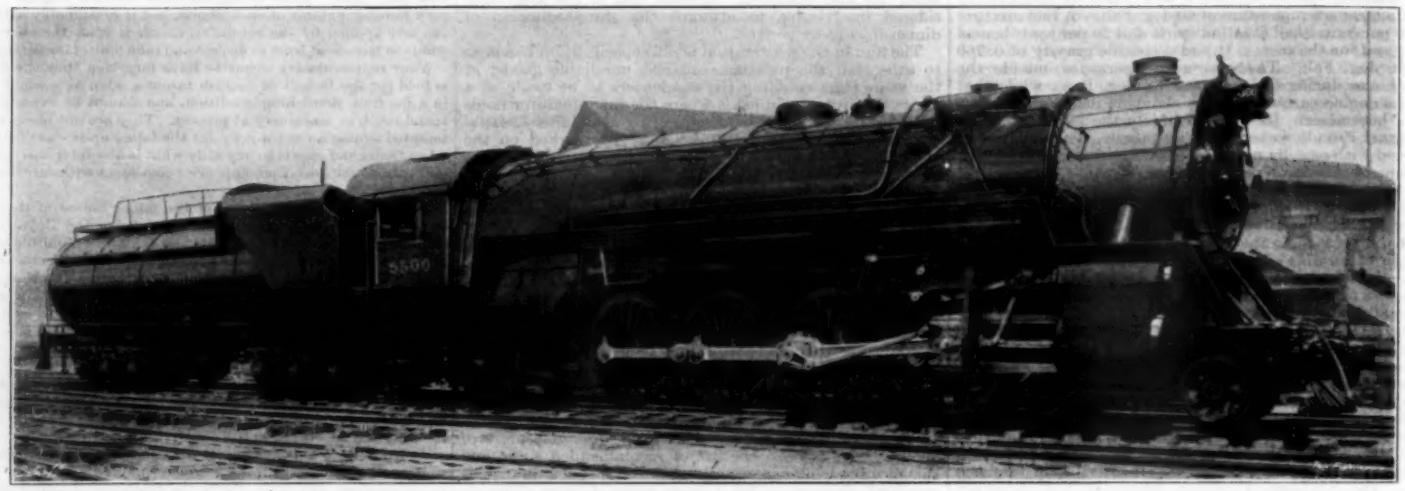
Leeds, December 21st.

[Our correspondents have, if we may say so, not interpreted our words quite correctly. They have given the word "lackadaisical" a general application to agricultural engineers. We did nothing of the kind. Again our attitude to the "discer" is far different from what they would make it appear. Our context reads: "This implement is decidedly interesting, through demonstrating how the disposition of material can be arranged to meet heavy stresses and yet avoid undue weight." We regard that as a distinctly engineering attitude.—ED. THE E.]

THE ROYAL INSTITUTION.—The following arrangements have been made for the before-Easter session of the Royal Institution:—**Friday Evening Discourses:** January 21st, Sir William Bragg, F.R.S., Fullerian Professor of Chemistry, "Tyndall's Experiments on Magne-crystallic Action;" January 28th, Dr. Edward P. Cathcart, F.R.S., Gardiner Professor of Chemical Physiology, University of Glasgow, "The Physique of Women Employed in Industry;" February 11th, Mr. Ernest Law, "Old Hampton Court Palace Revealed;" February 18th, Sir Josiah C. Stamp, President of the Executive, London, Midland and Scottish Railway, "The Laws of Monetary Science;" February 25th, Dr. D'Arcy W. Thompson, F.R.S., Professor of Natural History, University of St. Andrews, "The Solids of Plato and Archimedes;" March 4th, Sir Herbert Jackson, F.R.S., Director of Research, British Scientific Instruments Research Association, "Some Colouring Agents in Glasses and Glazes;" March 11th, Dr. George Macdonald, Permanent Secretary, Scottish Education Department, "The Wall of Hadrian;" March 18th, Mr. Emil Hatschek, Lecturer on Colloids, Sir John Cass Technical Institute, "Rigidity and other Anomalies in Colloidal Solutions;" March 25th, Dr. C. T. R. Wilson, F.R.S., Fellow of Sydney Sussex College, Jacksonian Professor of Natural Philosophy, Cambridge, "Thunderclouds;" April 1st, Mr. John Allen Howe, Assistant Director, Geological Survey, "The Stones of London;" and April 8th, Sir Ernest Rutherford, O.M., Pres. R.S., Professor of Natural Philosophy, R.I. and Cavendish, Professor of Experimental Physics, University of Cambridge (subject not yet announced). Juvenile Christmas lectures will consist of a series of six, entitled "Nerves and Muscles: How We Feel and Move," and they will be delivered by Mr. A. V. Hill, F.R.S., Foulerton Research Professor of the Royal Society. They will be given on (1) Tuesday, December 28th; (2) Thursday, December 30th; (3) Saturday, January 1st; (4) Tuesday, January 4th; (5) Thursday, January 6th; and (6) Saturday, January 8th, at 3 p.m. on each date. The general courses of lectures for the session will be as follows:—Tuesdays, January 18th, 25th (5.15 p.m.), "Smokes as Aerial Disperse Systems," by Mr. R. Whytlaw Gray, Professor of Chemistry, University of Leeds; Tuesdays, February 1st, 8th, 16th (Wednesday), 22nd, March 1st, 8th (5.15 p.m.), "Problems of Animal Growth and Development," by Mr. Julian B. Huxley, Professor of Zoology, King's College, London, Fullerian Professor of Physiology; Tuesdays, March 15th, 22nd (5.15 p.m.), "X-rays and the Chemical Molecule," by Dr. George Shearer, D.Sc., M.R.I., of the Davy Faraday Research Laboratory of the Royal Institution; Tuesdays, March 29th, April 5th (5.15 p.m.), "Some Properties of Coke," by Mr. John W. Cobb, Livesey Professor of Coal Gas and Fuel Industries, University of Leeds; Thursdays, January 20th, 27th (5.15 p.m.), "Romanesque and Early Pointed Architecture in Spain (Eleventh to Thirteenth Centuries)," by Mr. John R. H. Weaver, Fellow and Tutor of Trinity College, Oxford; Thursdays, February 3rd, 10th, 17th (5.15 p.m.), "Acoustical Problems Treated by Lord Rayleigh—(1) Æolian Tones, (2) Echoes, (3) Bells," by Sir William Bragg, F.R.S.; Thursdays, February 24th, March 3rd, 10th (5.15 p.m.), "The Progress of Hittite Studies," by Dr. John Garstang, John Rankin Professor of Archæology, University of Liverpool; Thursdays, March 17th, 24th (5.15 p.m.), "Colour Measurement and Standardisation," by Mr. J. Guild, of the National Physical Laboratory; Thursdays, March 31st, April 7th (5.15 p.m.), "The Beginnings and Early Spread of Agriculture," by Mr. Harold J. E. Peake, President of the Royal Anthropological Institute; Saturdays, January 22nd, 29th (3 p.m.), "English Mediæval Wall Painting, (1) Early, (2) Late," by Mr. E. W. Tristram, Professor, Royal College of Art, South Kensington; Saturdays, February 5th, 12th, 19th (3 p.m.), (1) "Craftsmanship in Verse," (2) "'Atmosphere' in Fiction," (3) "The Supernatural in Fiction," by Mr. Walter de la Mare; Saturdays, February 26th, March 5th, 12th (3 p.m.), "Beethoven," by Dr. John B. McEwen, Principal of the Royal Academy of Music; Saturdays, March 19th, 26th, April 2nd, 9th (3 p.m.), "The Alpha Rays and their Application to Atomic Structure," by Sir Ernest Rutherford, O.M., Pres. R.S.

BALTIMORE AND OHIO RAILWAY—300-TON PASSENGER LOCOMOTIVE

MR. G. H. EMERSON, BALTIMORE, ENGINEER



The Largest Passenger Locomotive.

By E. C. POULTNEY, O.B.E.

THE locomotive which forms the subject of this article has been built at the Mt. Clare shops of the Baltimore and Ohio Railway from the designs of Mr. G. H. Emerson, chief of motive power and equipment, and is the largest locomotive ever constructed for passenger service, weighing with tender in working order no less than 659,000 lb., or 294·2 long tons.

The Baltimore and Ohio has a particularly difficutl length of road passing over the Allegheny Mountains, known as the Cumberland Division, extending for 533 miles between Cumberland and Grafton, over which the gradients to be faced running in either direction are of a very severe character. Travelling from Cumberland, the line rises practically all the way to the summit at Altamont, 235 miles from the start, the last 80 miles being on rising gradients varying from 2·08 to 2·28 per cent. From Altamont to Terra Alta, about 100 miles, the line falls by 1 per cent. gradients for 50 miles and rises for the remaining distance at rates varying from 1 to 0·48 per cent., after which there comes a sharp drop to Rowlesburgh, 397 miles from Cumberland, on gradients of 1·5 to 2·2 per cent. The next 22 miles or thereabouts rise at about 2·01 per cent. and the last 114 miles fall at rates which vary from 2 per cent. for 20 miles and 0·9 to 0·3 per cent. for the remainder of the journey. It may be mentioned that the undulating table-land extending between Altamont and Terra Alta is from 2700ft. to 2550ft. above sea level. The maximum gradient is between Terra Alta and Rowlesburgh, at about the 345th mile post from Cumberland, at which point the line falls at 2·6 per cent., 137ft. per mile, or 1 in 37·5. For some time past heavy passenger trains have been operated over this section by "Pacific" type engines double headed, but the locomotive illustrated above and in diagram form in Fig. 1 has been designed to handle them unaided. It can haul over this section seven car trains having a total weight of 1,093,000 lb., or 488 long tons, which is the maximum load taken without assistance. Keeping in mind the weight of the locomotive, which is 294 tons, as against that of the trailing load 488 tons, an idea is obtained of the comparative size of the engine required when heavy gradients have to be negotiated. Of the total locomotive weight, 400,000 lb., or 178 tons, comprises the engine portion. This is equal to 36·5 per cent. of the train weight. The tender alone, with its 36,000 lb. of coal and 15,000 gallons of water, turns the scale at 259,000 lb., or 115·5 tons, which is equal to 23·7 per cent. of the train weight. For working over gradients of this nature the locomotive forms 37 per cent. of the total moving load, or, put in another way, for each ton of weight in the cars there is required 0·6 ton of locomotive weight.

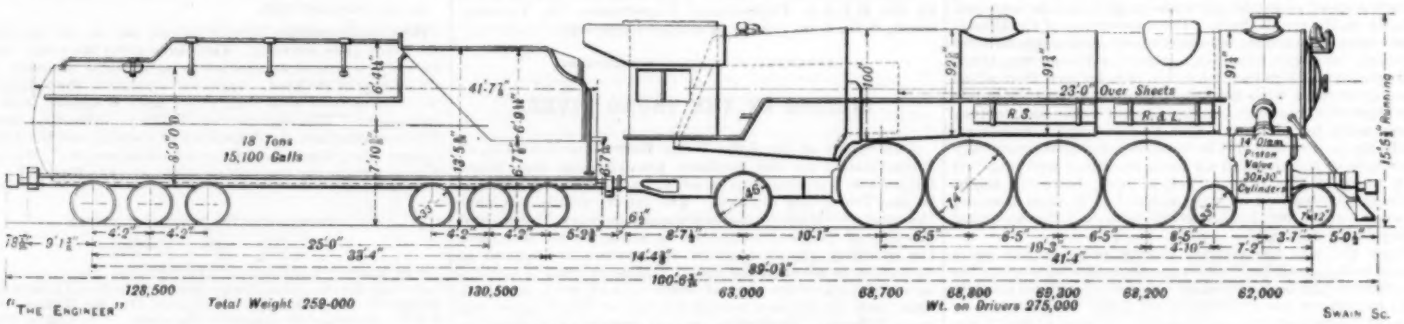


FIG. 1—PROFILE AND WEIGHT DIAGRAM

In order to bring out the probable performance of this locomotive on a gradient of 2·2 per cent. the diagram—Fig. 2—has been prepared. It shows the traction and train resistance curves. The upper curves indicate the traction effort available at the rim of the drivers at speeds up to 70 miles per hour and the next lower shows the available train, or what Professor A. J. Wood calls the "unbalanced" tractive effort curve.* These characteristics show, amongst other things, the power required to run the locomotive alone, and in this connection it is of interest to note that the engine could move itself over this profile at about 60 miles per hour.

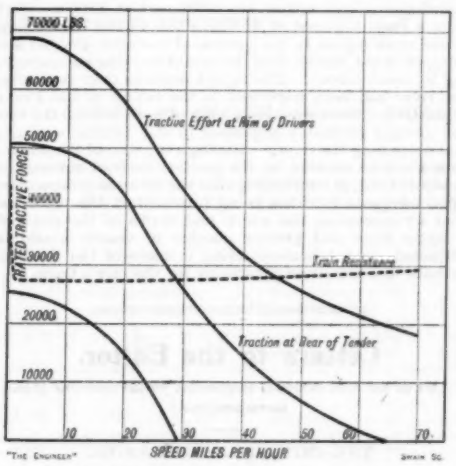


FIG. 2—LOCOMOTIVE PERFORMANCE CURVES

In order to bring the size of this locomotive into greater prominence the comparative data collected together in the tabulated statement giving the dimensions and proportion of previous mountain type locomotives have been drawn up. In all, nine different examples are given, arranged in order of weight. The new B. and O. engine easily heads the list, being 24,000 lb. heavier than the Delaware, Lackawanna Western design, which follows it. Of this excess weight 16,500 lb. are on the drivers to take care of the increased tractive effort of 13,362 lb. The column showing the cylinder horse-power gives this figure computed by the Cole method and is based on a piston speed of 1000ft. per minute.

In general, the designs call for little comment, but mention may be made of one or two of them. The U.S.R.A. is interesting, as it is the standard design of heavy 4–8–2 engine worked out during the period of Government control, and is jointly the product of the building firms and railway officers, whilst the Atchison, Topeka and Santa Fé (A.T. and S.F.) engines, when built in 1918, were the largest of their type. This locomotive was illustrated in THE ENGINEER, June 13th, 1919.

The new Baltimore and Ohio engines, beyond their great size and power, follow along the lines of conventional locomotive practice in the United States, and the general features can be noted from the illustration. The full gear cut-off is 88 per cent. A list of the leading dimensions of this notable locomotive is appended. It gives also the estimated powers and the boiler and weight ratios. It should be noticed that the axle weight on the drivers is

Comparative Particulars of Typical Mountain Type Passenger Locomotives.

Railway.	Total weight.	Adhesive weight.	Diameter drivers.	Cylinders.	Steam pressure.	Tractive force	Heating Surfaces. Evaps.	Superh'r.	Combined.	Grate area.	Cylinder H.P.	Comb. H.S. Grate area.	Comb. H.S. Cyl. H.P.	Total weight Comb. H.S.
	lb.	lb.	in.	in.	lb.	lb.	sq. ft.	sq. ft.	sq. ft.	sq. ft.				
B. and O.	400,000	274,000	74	30×30	220	68,200	5,591	1,305	6,896	89·17	3,568	77·2	1·93	58·2
D.L. and W.	376,000	257,500	69	28×30	200	54,838	4,974	1,242	6,216	84·0	2,824	78·0	2·20	59·8
G.N.	357,000	283,000	73	29×28	200	54,830	4,971	1,368	6,339	88·0	3,030	72·0	2·12	56·3
A.T.S.F.	353,900	227,700	69	28×28	200	54,100	4,792	1,087	5,879	71·7	2,824	81·9	2·07	65·5
U.S.R.A.	352,000	243,000	69	28×30	200	58,000	4,666	1,085	5,751	76·3	2,824	75·3	2·04	61·2
U.P.	345,000	230,000	73	29×28	200	54,838	4,974	1,242	6,216	84·0	3,030	74·2	2·05	55·4
N. and W.	341,000	236,000	70	29×28	200	57,200	3,984	882	4,866	80·3	3,030	60·6	1·61	71·5
N.Y.O. and W.	317,000	208,200	69	27×28	200	50,300	3,654	1,010	4,664	66·8	2,624	69·5	1·78	68·2
S.R.	314,000	214,800	69	27×28	190	47,800	3,668	942	4,610	66·7	2,624	69·2	1·75	68·2

NOTE.—Tractive force calculated by taking the M.E.P. as 85 per cent. of the boiler working pressure.

* "Locomotive Operation," Arthur J. Wood.

in the neighbourhood of 30 tons. The writer is indebted to Mr. G. H. Emerson for the photograph and weight diagram and other data, on which this article on the world's largest passenger locomotive are principally based.

General Particulars.

Total weight, engine	400,000 lb.
Adhesive weight	275,000 lb.
Tender weight	259,000 lb.
Total engine and tender	934,000 lb.
Cylinders (two)	30in. by 30in.
Valves, type	Piston, 14in. dia.
Wheels—	
Driving	74in. dia.
Leading truck	33in.
Trailing truck	46in.
Boiler steam pressure	220 lb. per sq. in.
Boiler diameter, largest outside	100in.
Tubes, number and diameter	269—2¼in.
Flues, number and diameter	48—5½in.
Length between tube plates	22in.–10⅝in.
Fire-box, size inside	96in. by 132¼in.
Heating surfaces—	
Tubes	3626 sq. ft.
Flues	1582 sq. ft.
Fire-box, including combustion chamber and tubes	383 sq. ft.
Total evaporative	5591 sq. ft.
Superheater	1305 sq. ft.
Total combined	6896 sq. ft.
Grate area	89·17 sq. ft.
Special equipment—	
Valve gear	Baker
Reverse gear	Ragonnet "B"
Stoker	Duplex
Superheater	Type A

General Data Estimated.

Rated tractive force, M.E.P., 85 per cent. boiler pressure	68,200 lb.
Cylinder H.P. (Cole) at 1000ft. piston speed	3568
Speed at above power	44 m.p.h.

Ratios.

Boiler proportions—	
Rated tractive force ÷ comb. heating surface	= 9·9
R.T.F. × dia. of drivers ÷ comb. heating surface	= 73·1
Comb. heating surface ÷ grate area	= 77·3
Fire-box heating surface × 100 ÷ comb. H.S.	= 5·56
Superheater surface × 100 ÷ comb. H.S.	= 18·95
Weight proportions—	
Adhesive weight ÷ R.T.F.	= 4·03
Adhesive weight × 100 ÷ total weight	= 69
Total weight ÷ comb. H.S.	= 58·2.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Christmas Holidays.

BUSINESS on the Midland iron and steel market this week has been practically suspended, most of the works having sufficient material to enable them to carry on till the works close down, at the week end, for the Christmas vacation. Buyers are not prepared, under present conditions, to enter into forward commitments on any terms, and they express their intention not to buy forward until prices come down. It is considered fairly assured that iron and steel values will fall, but in some quarters it is held that steel values are likely to appreciate further before the decline comes. Much now depends upon the rapidity with which prices of material come down to the pre-strike level. The heavy industries of the Midlands, which have experienced such a sorry time in the last six months, are beginning to show signs of activity once more. Inquiries have been circulating with greater freedom, though even they are now held up until after the Christmas break. Industrialists, however, are busy putting everything in order, so that there will be the least possible delay when ample supplies of steel are once more available. It is at present impossible to state when the Black Country blast-furnaces are likely to be put into commission again, as coke supplies are entirely inadequate just now. A few engineering firms have been busy clearing up business before the holidays, but they are anxious as to future supplies of steel. Probably no district has this week been busier in proportion to its size than the Black Country. There is a standing condition that every opportunity should be taken to give the men full work before Christmas, and, on many occasions, mills have manufactured for stock solely for that purpose. This year there is no such necessity, a brisk demand existing for all the material that the mills can turn out. In some quarters there has been a suggestion that the holiday period should on this occasion be shortened, but nothing appears to have been actually accomplished, and most of the works in this district will be idle for the greater portion of next week. At some of the works stocktaking will be got out of the way in the interim, so that once restarted work will, all being well, proceed uninterrupted for, it is hoped, a considerable time.

Pig Iron.

Comparatively little business was done this week in pig iron. Furnace owners have made the best of their opportunities in restarting furnaces, but the effect has scarcely yet been felt on the market. Nearly all the furnaces started are owned by firms producing pig iron for their own requirements, and therefore only a limited quantity has come on to the market. The output of these furnaces is now stated to be committed over the first two months of next year. The small sales of pig iron effected have been on the basis of £4 12s. 6d. for Derbyshire, a fairly high price, but customers have been very glad to pay the figure to get their customary iron. Some iron of the same grade is reported to have been sold for February delivery at £4 5s. A lot of French pig iron has been booked at the high price of £5 delivered, and that figure is likely to rule well into the New Year. A considerable amount of continental pig iron has to come into this district against engagements made when the outlook was precarious, and that is naturally influencing the position. Offers of pig iron this week by native furnacemen suggested that a number of smelters are completing plans for blowing in furnaces early in the New Year. The coke situation is still perplexing, however. It is difficult to come to an agreement as to what is a reasonable basis. Ovenmen are holding out for 20s. per ton, but they have outstanding contracts to complete at appreciably lower rates. Those are being worked off, but very slowly. Pig iron producers demur strongly to the price named, maintaining that profitable production with fuel at such a figure would be impossible. Until some agreement as to values can be reached no general blowing in of furnaces is to be expected, and until pig iron is again freely offered other branches of industry will be prevented from producing to their full capacity.

Prospect of High Steel Prices.

There is an increasing opinion here that a period—brief, it is hoped—of high steel prices is in prospect. It is argued that it will be some months before the supply of pig iron and steel overtakes the demand. January, it is clear, will be a month of small production. The heavy steel mills have booked such substantial orders that in many cases they have six months work on hand, and are now very careful about taking on further obligations. It is noticeable that some firms, which a week ago were booking at £8 10s., are now asking £9. Furthermore, it is understood that the Steel Association has been considering the possibility of, and hints have been given that, a rise of 10s. per ton on finished steel is a contingency to be expected. Higher prices of steel associated with cheaper coal would undoubtedly be a boon to many steel works who have been fighting against enormous obstacles, but hope is expressed that prices will continue moderate as a means of encouraging the placing of many contracts which have for months been held up, and which if native prices appreciate may find their way to the Continent. In the Midlands this week small steel bars were quoted £9. For plates £8 17s. 6d. was asked, but the delivery dates are distant. There were no English billets on the market, except some high carbon qualities. Continental soft billets were cheaper at £6 2s. 6d.

Fuel and Steel Furnaces.

The reduction in coal prices is being followed very closely by steelmasters in the Midlands, who hope to see them reach something like pre-strike level before the New Year. The blowing in of steel furnaces is very closely associated with the price of coal, and the more rapid the reduction in fuel charges the more quickly will the furnaces get to work. The first essential to ample supplies of furnace coke is cheap fuel, and a practical obstacle to the making of furnace coke is the ability to sell raw fuel more profitably than in coke form. Prices, however, have come down sharply, the movement having been accelerated by the railway congestion which is holding up thousands of wagons.

Where Staffordshire Gains.

The dearth of wagons for the conveyance of coal to works and various centres of distribution, due to railway congestion, has caused widespread hindrance at the coal-consuming works. In many instances sufficient supplies to keep the plant running at full pressure, which the work in hand justifies, have not been obtainable. It is on such occasions as this that Staffordshire benefits from possession of its canals linking up the works with the Cannock Chase collieries, and it is understood that many Staffordshire ironmasters have bought favourably through their ability to relieve collieries otherwise unprovided with the means of transport.

Finished Iron.

There has been a keen demand for Staffordshire finished iron since the mills resumed work, and that demand is likely to be increased as soon as the holidays are over. Makers have no difficulty in securing the official price of £14 10s. per ton for marked bars. It was stated this week that makers are determined to keep prices as low as they can, and it is contended that the smallness of the recent price increase is proof of this. In the Crown bar department Lancashire producers are competing strongly for the available business. Like the Staffordshire makers, they quote £12 15s. A fair amount of business is passing. Nut and bolt bars at £11 5s. are stated by Black Country consumers to be too dear. They have in most instances fairly substantial contracts with continental houses, but even when these run out business with Staffordshire ironmasters at present rates will hardly be considered. Best grade wrought iron tube strip continues to be quoted up to £15.

Cheaper Galvanised Sheets.

Galvanised sheets have undergone a further reduction. For several weeks past the price has been reduced at the rate of 5s. per week, and sheets are cheaper by this amount as compared with last week, the selling price of 24-gauge corrugateds being £16 15s. It is said that occasionally still lower prices can be accepted. It is held the fall is likely to go on as long as the reduction in fuel values continues, even though up to now the supply of sheet bars has not appreciably improved.

Trade Returns.

As was to be expected, the trade returns for the month of November show that while imports of iron and steel continue to increase exports are still on the decline. It is rather remarkable, however, how well the latter have kept up when we consider the almost complete disorganisation of production brought about by the coal strike. That we have been able during the past six months to export iron and steel to the extent we have is due almost entirely to the enormous stocks which producers and merchants must have held, and to the reinforcement of the finished trade with raw material from the Continent. Though in November exports of iron and steel were no more than 166,363 tons, against 398,235 tons in October, and 445,704 tons in September, for the eleven months of the year which have passed exports totalled 2,829,005 tons, against 3,389,952 tons in 1925 and 3,549,816 tons in 1924. The twelfth month, unfortunately, is not likely to modify the downward tendency very conspicuously. On the other hand, in the eleven months to the end of November imports of iron and steel in their various stages of manufacture increased to 3,223,144 tons, as compared with 2,471,425 tons in the trying conditions which prevailed in the corresponding period of 1925. The difference in cost was nearly four million. Last month the quantity of iron and steel imported was roughly double that of November, 1925. It was in crude material and half products that the increase was most noticeable, the difference in value being one-third. Shipments of pig iron amounted to about 75,000 tons, against 23,000 tons; steel blooms, billets, &c., to 75,000 tons, against 50,000 tons; iron bars, rods, angles, &c., to 25,000 tons, against 13,241 tons; sheet bars and tin-plate bars to 91,000 tons, against 43,000 tons. The total was 422,679 tons, or 25,000 tons more than in October.

Iron and Steel Position.

The position of the iron and steel industry at the end of November was indicated by the returns of production recently issued by the National Federation of Iron and Steel Manufacturers. Two additional blast-furnaces were blown in towards the end of November, bringing the total to seven in operation at the end of the month, compared with 147 on the eve of the coal stoppage. Production of pig iron in November showed a decrease on the previous month. It amounted to 12,700 tons, compared with 13,100 tons in October, 539,100 tons in April, and 494,100 tons in November, 1925. The production of steel increased slightly, amounting to 97,500 tons, compared with 94,200 tons in October, 661,000 tons in April, and 653,800 tons in November, 1925.

Contract for Stafford Firm.

I am given to understand that a contract for eight metre gauge locomotives for the Gaekwar of Baroda's State Railways has been awarded to W. G. Bagnall, Ltd., of Stafford. It will be welcomed as a good augury for the New Year.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery Exports.

EXPORTS of British textile machinery last month at £947,766, whilst considerably less than the figure in the corresponding period of last year—£1,015,530—are nearly £100,000 better than in October. The improvement is more than accounted for by the increased shipments to Russia, the exports to that country during the month being double those to any other individual market. Compared with £105,182 in October and only £16,871 in November, 1925, last month Russia took textile machinery to the value of £293,606. The Dutch East Indies were the second best market during the month, with exports valued at £138,006, "other European countries" coming next with £127,527, followed by South America with £94,506, France £52,469, the Netherlands £52,306, Japan £48,866, Germany £35,858, Australia £32,933, the United States £25,243, and China £18,544. Of the total shipments of textile machinery during the month, spinning and twisting machinery was responsible for £756,424, and weaving machinery for £125,709. Altogether during the period January–November of this year exports of all kinds of textile machinery amounted to £9,106,728, compared with £11,099,112 in the corresponding eleven months of last year and £9,924,187 in 1924.

Trade Secrets.

In granting an injunction restraining a defendant—Vincent Platt—a former foreman, from using to their detriment or communicating to others information relating to three machines which the plaintiffs—Wadsworth and Co., Ltd., jacquard makers, of Droyleaden and Blackpool—regarded as trade secrets, Vice-Chancellor Courthorpe Wilson, K.C., in the Manchester Chancery Court this week, said it was sufficient for the plaintiffs to show that the defendant took memoranda of the measurements in breach of his contract of employment, and of the confidence reposed in him by his employers; it was not necessary for the plaintiffs to prove that the processes and designs of the machines were trade secrets. The allegation of the plaintiffs was that the defendant, who left their employment last February, had wrongfully made and taken away sketches of the machines with the intention of using them in connection with another business.

Back to Full Time.

The Foden Motor Wagon Works, at Sandbach, Cheshire, last week returned to full time, the employees for a short period having been working only on alternate weeks. It is announced that orders are coming in in large numbers, and that inquiries are being made from Poland and Chile. The future prospects are regarded as good, although operations are likely to be interfered with for a few weeks, because of the shortage of raw materials. The trade prospects with Chile are extremely bright, but as in the case of Poland, from five to ten years' credit is required, and no policy has yet been definitely decided upon in espect of the inquiries from that country.

Local Contracts.

The Manchester Corporation has placed the contract for the supply of structural steel work required in connection with the extensions at Barton electricity works with Edward Wood and Co., Ltd., Ocean Ironworks, Manchester. To complete the additions to be made to the turbine and pump house, switch-rooms, &c., it is esti-

mated that about 1500 tons of steel work will be needed. According to a Capetown message, only one British firm, Beyer, Peacock and Co., Ltd., Gorton, Manchester, who specialise in the Garratt type of engine, are likely to receive an order from the South African Government for one or more of the fifty-six locomotives which are to be built for the South African Railways, the probability being, it is stated, that the contract for the remainder will be placed with German firms. It is interesting to note, by the way, that the London, Midland and Scottish Railway will shortly begin trials on the London, Manchester and Glasgow express routes with the Ljungstrom steam turbine locomotive which Messrs. Beyer, Peacock are making.

Electrical Plant for Bury.

The Bury Town Council contemplates spending about £116,000 in connection with extensions and substitutions of plant at the Corporation electricity works.

Liverpool's £8,000,000 Dock.

Liverpool's new Gladstone Dock, according to a statement made by Mr. T. H. Newell, engineer-in-chief to the Mersey Docks and Harbour Board, will be ready for opening in February. The dock, which has cost about £8,000,000, has been in course of construction for twenty years, work on it having been held up during the war years.

Personal.

Mr. A. P. Ross, who has been engineer of the Cheshire Lines Railway since 1917, has been appointed to fill the vacancy of manager and engineer caused by the death of Mr. W. H. Oates. Before joining the Cheshire Lines' staff at Liverpool, Mr. Ross was assistant engineer to the Great Northern Railway at King's Cross. He is the son of the late Mr. Alexander Ross, at one time district engineer at Edge Hill, Liverpool, of the London and North-Western Railway.

Non-ferrous Metals.

The market for non-ferrous metals has undergone a comparatively uneventful week so far as price fluctuations are concerned, and in no instance have the changes compared with the previous week been of much consequence. In spite of an estimated increase of about 300 tons in the domestic stocks of tin, and a much-reduced turnover compared with the week before, the price of the metal finished up showing a slight gain, the bullish factors being an anticipated increase in the trade consumption, both at home and in the United States, where the demand is already of fair dimensions. Dealings in copper have also been on a reduced scale, and after a week in which at times a certain amount of dulness has been in evidence, prices have finished slightly lower. Some good orders for wire bars have been placed by cable makers on January account. In the case of spelter, there has been an increased turnover and prices have kept fairly steady, although quotations are perhaps a shade lower than they were a week ago. Inquiry for lead has been on a moderate scale, and values have shown some improvement.

Iron.

There has been little sign of activity in the iron market here this week, and until supplies improve, as they are expected to do next month, with a probability of lower prices before long, there is not likely to be any great movement of the metal. In the meantime, prices quoted on the Manchester market during the last day or two have been fully maintained, for forward delivery at all events, with Derbyshire at 100s. per ton delivered for January and 92s. 6d. for February, Middlesbrough at 100s. to 102s., Scottish at up to 117s. 6d., and West Coast hematite at 100s. to 105s. There are still no offers of East Coast hematite for forward delivery, and I understand that none is expected to be available until February or March. Lancashire bar makers maintain their quotations at the last increase, Crown quality being offered at £12 10s. per ton delivered, and seconds at £11 5s. per ton. Most of them are busy on the execution of orders in hand and in the rebuilding of stocks, but this week has been a quiet period from the point of view of new business.

Steel.

A feature of the steel market here has been the increasing weakness of continental steel, and although not every section has shown a decline compared with last week, certain modifications have been made in the quotations for semi-finished materials and also in joists and sections. Further shadings in prices are expected in the near future when British steels make their appearance in quantity. Current values for delivery to Manchester works for cash against documents are £6 10s. to £6 12s. 6d. per ton for joists and sections, £6 to £6 2s. 6d. for billets, £6 2s. 6d. to £6 5s. for sheet bars, £7 2s. 6d. to £7 5s. for wire rods, £7 7s. 6d. to £7 10s. for light plates, and £7 15s. per ton for Siemens plates. Inquiry for home-manufactured steels has also been quieter this week, but prices generally keep firm. Tank plates are on offer at from £8 15s. to £9 per ton, boiler plates at £11 10s. to £11 15s., basic bars at £9 to £9 5s., and joists and sections at £8 to £8 5s. per ton delivered Manchester. Re-rolled bars are slow but about unchanged at £9 5s. per ton. For basic wire drawing billets about £9 5s. per ton is being asked here, with acid billets at £10 10s. A very poor demand still characterises the market for galvanised sheets, with a certain amount of weakness in evidence, 24 gauges now being no better than £16 10s. per ton f.o.b. Thin gauges are still being quoted here at £25 2s. 6d. per ton for Rangoons, £24 5s. for Bangkoks, £23 5s. for Straits, and £25 10s. for Shanghais, but very little inquiry is coming through just now from the Far Eastern markets.

BARROW-IN-FURNESS.

Hematite.

Once the holidays are over production of hematite pig iron will proceed apace, and, providing there are no disputes in any industry affecting the iron trade, this district is certain to experience better and more steady conditions than it has for years. The whole of the area seems to entertain this opinion, and there is a general feeling of optimism. No one suggests a boom, but just a good steady run of trade which, after all, is the best, for past experience has taught us that slumps follow booms, and that some of the booms have very brief lives. The markets are quiet, simply for the reason that most of the orders are placed and business will revive as regards further orders when deliveries have been made. Special qualities have received considerable attention, makers holding heavy orders for them.

Iron Ore.

There is little to say about the iron ore industry, beyond stating that native ore is going to have a better and more steady demand than it has had for years, and also that the outside trade will increase. The importation of foreign ore will be restarting now, and will continue regularly. Outward coal cargoes will help freights in the foreign ore trade.

Steel.

The increase last week of 10s. per ton for steel rails may be taken more as a sign that the price was being brought up to the ruling price of iron rather than of a sudden spurt in the market. The market remains fairly quiet, but the future holds promise.

SHEFFIELD.

(From our own Correspondent.)

Furnaces Restarted.

Although the melting of steel for general consumption has not been resumed in this district, and is not likely to be until the New Year, several firms are now producing material for their own needs, and, as a consequence, the manufacturing sides of their operations are showing increased activity. The firm which has restarted production to the largest extent is the United Steel Companies, Ltd., which expects, by the end of this week, to have eight furnaces working—five at Templeborough and three at the Ickles. The possession of heavy stocks of raw material has enabled this firm to resume work quickly. Both basic and acid steel are being produced, and for a time the chief bulk of the output will be needed for the company's own mills and other plant. Henry Bessemer and Co., Ltd., are again producing acid steel, having lighted up two furnaces. They have on hand good orders for rolling stock forgings of high grade. Other firms are increasing their production of railway material, including Cammell Laird and Co., Ltd., who have restarted their tire mills at Penistone. It is probable that the furnaces and other plant which have been restarted in this district will continue to work right through the Christmas period. The settlement of the coal strike has already helped in some degree to reduce unemployment in Sheffield, and last week there was a fall of 1910. The total figure of wholly or partially unemployed in the city is still very high, however, being upwards of 29,000, and it will be a considerable time before any large proportion of these workers can be absorbed.

A Lincolnshire Development.

Much progress has been made with the erection and equipment of the new plate mills of the United Steel Companies at Appleby, Lincolnshire. During the strike workmen were giving the finishing touches to the plant, and it is expected that work will be started very shortly. The mills will be among the largest in the country, and will obtain their steel from the United Steel Companies' works at Frodingham. The Appleby plant originally consisted of blast-furnaces only, which were used for dealing with the iron ore from the company's adjacent properties. The extensions were started during the war, when the Appleby Company, in compliance with a request of the Government, undertook the construction of blast and steel furnaces, and modern mills for the rolling of plates for shipbuilding and tank purposes. A Government subsidy was given, amounting, it is understood, to £650,000. The total cost of the extensions has been something like £4,000,000. The existence of the plant will enable the company to cater for the requirements of the shipbuilding yards of the Humber, and the boiler and tank works of the West Riding, and will open up other sources of trade.

Wire Rope and Tools.

There has been a considerable improvement in the wire rope trade since the close of the dispute. British collieries, which had bought little or nothing for several months, are now sending in orders for large requirements. There has been a brisk overseas demand for a good while, and this is well maintained. The bulk of the wire rope trade abroad is done by this country. An example of the leading position which we occupy is furnished by India, which, during the seven months up to the end of September, imported 1400 tons of wire rope, all but about 100 tons of which came from the United Kingdom. Makers of joiners' and farm tools, and some other classes of hand tools, continue to enjoy much activity, but the position generally, especially in regard to files, is much affected by the absence of large orders from Russia. There is a continued good demand for all kinds of building tools and ironwork.

Cutlery and Plate.

The seasonal demand in the cutlery and plate trades has continued longer than was expected, a considerable amount of activity having followed the termination of the coal dispute. A good many of the houses have continued fairly busy up to the time of writing. The majority of the orders are small individually, and a great many of them are for cheap lines, but the amount of employment which they provide in the aggregate is very good. These trades have not really been in a satisfactory condition for the last three or four years, but there is an optimistic feeling with regard to the future, and it is generally believed that 1927 will show a considerable improvement on 1926.

Grimsby Pulp Mill Project.

At the annual meeting of the Grimsby Chamber of Commerce and Shipping, Captain Man, the port master, replied to criticisms which have been made against the railway company in connection with Peter Dixon and Son's project for establishing a pulp mill there, to which I referred on December 10th. It will be remembered that Messrs. Dixon have now decided to form a Finnish company for the purpose of making paper pulp in that country. Captain Man stated that Messrs. Dixon gave the railway company figures of the material which they estimated they would handle, and asked it to ascertain what alterations in organisation would be necessary to cope with the traffic. The company found it would have to spend between £40,000 and £50,000 at Grimsby and Immingham in providing cranes alone. There were other expenses in addition, such as engine power. These points were put before Messrs. Dixon, who introduced fresh points as to the financial side of the venture. Briefly, they wanted a heavy rebate on every service of the railway company—a very big reduction of normal rates. They also asked for an immediate decision, as their principal was abroad, conducting negotiations there. The great thing which Messrs. Dixon asked for was that they should be given the export rate on coal for the new mill. This would have immediately affected every exporter in the country. It was a thing which the railway company could not do, said Captain Man, and eventually it had to tell Messrs. Dixon that it could not meet them.

Coal Development at Normanton.

The Mines (Working Facilities and Support) Acts, 1923 and 1925, are having valuable results in enabling small parcels of coal to be worked which might otherwise be lost to the country. The latest instance comes from Normanton, where Pope and Pearson, Ltd., of the West Riding and Silkstone collieries, Altofts, have just received sanction from the Railway and Canal Commission to work about 120 acres of the Silkstone seam. It was stated that the company was already working 2500 acres. It proposed to work the new area from its Flockton workings, and if it did not secure power to do so the coal would probably be left, as no other colliery could work it. The seam, it was stated, lay at a depth of 440 yards, and was 3ft. 6in. in thickness. It was proposed to work it on the grid-iron system. It was not expected that there would be more than an inch or two of subsidence, but the company was prepared to pay for any damage. The coal would be worth £1 a ton, and it was estimated that there would be a yield of 160,000 tons. It was proposed to pay £90 per acre royalty. The working of the area would enable the company to employ 150 men.

New Electricity Supplies.

The power plant extensions which the Worksop Council has recently completed at its electricity works were formally opened last week. A new steel-framed and asbestos-cement sheeted building has been erected adjoining the existing brick power-house, making one large engine-room. Here is housed the new plant, consisting of two Vickers-Petter 510–550 brake horse-power heavy oil engines, driving two Metropolitan-Vickers shunt-wound, interpole, direct-current generators, each of 320 kilowatts, at 460–550 volts. The generators are of the two-bearing type, and are direct coupled to the engine fly-wheels. The new electricity supply of Newark was also formally switched on during the week. The current is obtained in bulk from the Derbyshire and Nottinghamshire Power Company. The line is brought to Newark from Kirkby-in-Ashfield, about 24 miles away, and the villages *en route* will be able to benefit by the scheme. "Barrow" suspension type fittings have been installed for the lighting of the Great North Road through the town of Newark.

Sewage Schemes.

The West Riding Rivers Board has given notice to the Rotherham Corporation of its intention to take proceedings against it for allowing crude sewage to enter the river at the storm overflow at the tram sheds in Rawmarsh-road, Rotherham. At a meeting of the Board it was reported that the Rotherham Corporation had decided to apply to the Ministry of Health for sanction to borrow £10,000 to carry out work designed to prevent the discharge of about 500,000 gallons of sewage a day into the river. Upon this, the Board decided to let the question of proceedings stand over until February. A public inquiry has been held with regard to the proposal of the Worksop Rural Council to borrow £6023 for the purpose of carrying out the second instalment of the Harworth sewerage and sewage disposal scheme.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade Conditions.

WITH the approach of the holiday season there has been little disposition to do business in commercial circles in the North of England, but a very optimistic view is taken of the outlook, and a period of great activity is expected in the New Year. Ironmasters are still handicapped in their efforts to restart more furnaces, owing to the shortage of coke, while the marked scarcity of wagons is holding up progress in many directions. At the moment, the want of trucks is a constant source of anxiety to the collieries, both in Northumberland and Durham, and lost output has been reported. Imported coals are still being discharged at East Coast ports, and this fact is making it difficult to get the larger supply of wagons required for the export trade. After the end of the year, when the iron

ore boats will be arriving for the blast-furnaces, still more wagons will be required, so that the pressure is likely to be exceptional for some time to come.

Cleveland Iron Trade.

Seasonal quietness in the Cleveland pig iron trade has been less marked than usual, as a result of the abnormal position. The shortage of iron is still acute. Many blast-furnaces have been lighted, but few are as yet producing marketable iron, and as the steel firms must first meet their own requirements, there is very little iron indeed available for ordinary commercial purposes. Moreover, the makers appear to have sold in anticipation of a bigger output, and have consequently nothing to spare after meeting their commitments. The result is that prompt supplies of Cleveland foundry iron are unobtainable, and even for January delivery producers are somewhat reluctant to quote. Output, however, is being steadily increased, two more furnaces having been put into operation, which brings the total up to twenty-three. While there is still a feeling of uncertainty as to levels at which values are likely to settle, disposition to negotiate ahead is growing, and indeed a good many contracts have been made for forward delivery. Manufacturers as yet, however, are compelled to pursue a cautious policy in fixing definite dates for delivery. Very little iron is purchasable for delivery before February, and for supply over the second two months of the year No. 1 is 90s.; No. 3 G.M.B. Cleveland pig iron 87s. 6d., No. 4 foundry 86s. 6d., and No. 4 forge 85s. 6d.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is practically unchanged. Beyond a few odd parcels of off grades of iron, hematite cannot be bought for supply before March, and for delivery of mixed numbers that month and onwards, makers quote 92s. 6d. per ton.

Ironmaking Materials.

The foreign ore trade is without any new feature of moment. Consumers are very well placed as regards supplies, and are not disposed to discuss new business under existing conditions. There are, however, indications of preparations to resume deliveries in fulfilment of old contracts. Blast-furnace coke is now on sale at 25s. per ton delivered at North-East Coast works, but only for next year's contracts, and it is the scarcity of prompt supplies of coke at a reasonable figure which is holding up the re-lighting of many more furnaces.

Manufactured Iron and Steel.

Progress in the direction of re-starting steel-producing plant is proceeding very rapidly, and indications are not lacking that a return to something like normal output will be experienced early in the New Year. There is still a fair amount of buying of continental semi-finished steel, little of the local products being available for the market. Sales of finished steel manufactured in this district are reported to be on a moderate scale on home account, demand being largely for constructional material. Very active conditions prevail in the galvanised sheet trade, heavy orders being held by most makers. Galvanised corrugated sheets of 24 gauge are quoted at £16 5s. per ton.

The Coal Trade.

The position in the Northern coal trade so far as new business is concerned is very disappointing. A rather brisk trade in all classes had been confidently anticipated, but on the whole business has been sparingly offered, and the requirements under old contracts have not reached anything like the general volume anticipated. The whole market position is weak and generally disappointing. Prices for the remainder of this month are held to recent figures, and for next month producers are asking similar values, but find little business on offer, and merchants anticipate that values will further decline for next year's trade. In second hands best Northumberland steams are said to have been sold at 20s. 6d. for January, but direct prices are 1s. 6d. above that figure. None of the collieries, however, are pressing supplies for next month, believing that a steady tone is approaching. There is no special movement in the gas coal position. Best qualities are nominal at 23s., with second qualities just a little firmer at 20s. to 20s. 6d. The coke trade is quiet. Gas coke is in good demand for local domestic use, and from London areas, but for export the prices asked check shipments. Anything from 35s. to 40s. is still asked by makers. Foundry coke is slow at 32s. to 34s.

Ironworkers' Forego Wage Advance.

Blast-furnacemen on the North-East Coast have decided to forego any advance in wages to which they will become entitled to as the result of the current quarter's ascertainment. Their frank acknowledgment of the fictitious character of current iron prices constitutes not only a tribute to a collective sense of fair dealing, but also to their far-sightedness. Had they insisted upon the increases to which they were entitled under the sliding scale agreement, production costs would have been forced up, with a consequent decrease in the employment capacity of the plants. Many ironmasters would not, in fact, blow in their furnaces whilst real iron values were so far out of proportion to wages. Prices were forced up to artificial levels by the stoppage of fuel supplies, and by the fact that only two furnaces in the area were producing iron during the greater period of the coal dispute. The heavy additional cost of production was, quite naturally, reflected in the prices demanded for the product of the two operating furnaces. Realising that it would be unfair to insist upon the observance of the letter of the agreement, the blast-furnacemen's officials have intimated to the ironmasters their willingness to accept unchanged for the ensuing quarter the same percentage on the base rate as is being paid on the third quarter's ascertainment. At present the blast-furnacemen are receiving a sliding scale percentage equivalent to an ascertained price of 68s. 9d. per ton for No. 3 Cleveland pig iron. The ascertained price for the fourth quarter of this year will not be available until early in January, but having regard to quotations during the past three months, the average price will probably be not less than 100s. per ton, a figure which would have given the men an advance of about 30 per cent.

SCOTLAND.

(From our own Correspondent.)

Limited Operations.

WITH the various industries in course of reorganisation, it naturally follows that activities are limited. In all departments efforts are chiefly directed towards re-establishing economic productive standards in relation to costs and outputs, and it is unlikely that definite progress can be realised until after the turn of the year. Only a small proportion of the steel and iron works are now in operation, and then only on a partial scale. Apart from the question of the price of coal, the scarcity of pig iron may postpone the general resumption of work.

Shipbuilding Orders.

The Clan Line Steamers, Ltd., of Glasgow and London, has placed an order with the Greenock Dockyard Company for a motor-propelled vessel of about 10,000 tons deadweight, the machinery to be of the Burmeister and Wain type, and supplied by J. G. Kincaid and Co., Greenock. Messrs. Harland and Wolff are to build two vessels at their Greenock yard, one of which will be a modern type cargo steamer for the Hain Steamship Company (one of Lord Inchcape's associated companies). The other vessel will be a high-powered twin-screw tug for the P. and O. Company's service at Aden. Messrs. Harland and Wolff have also secured an order for two small oil tankers, in addition to four already ordered, from the Anglo-Saxon Petroleum Company, Ltd., London.

Steel.

The majority of the steel works are delaying a restart until coal prices are approximately on the pre-strike level, and managements are assured of uninterrupted production for some time to come. Messrs. Stewarts and Lloyds' Mossend Works were reopened last week, and the Dalziel Works of Messrs. David Colville and Sons, Motherwell, restarted this week. Messrs. Hurst, Nelson's wagon works in the same district have also restarted. Steel makers have enough orders on hand to give full employment for some months ahead, but, as already stated, the majority await the establishment of economic conditions. Black and galvanised sheets have experienced an abnormal demand for this time of the year. Supplies for December-January shipment are now unobtainable, and export orders are now being booked for February-March loading. Steel re-rollers are comparatively well employed, but are still dependent on continental raw materials.

Iron.

A number of bar iron works are now in operation. Outputs are fair, but are chiefly made up of steel, rolled from foreign material, the present price of fuel being against the production of iron. Iron is being made, but there is no particular activity in that department.

Pig Iron.

Business in pig iron continues on a meagre scale. Certain brands of foundry have been unobtainable for a considerable period, and any odd lots available are quoted at high prices. Five blast-furnaces have been re-lit, and this number will be added to early in January next.

Coal.

Conditions in the coal trade generally show little alteration. Buying on home account is pretty much of the "hand-to-mouth" variety, even allowing for the additional demand on account of any works re-starting, and prices, especially of nuts, show further weakness. For land sales screened steam is quoted 24s. to 26s.; unscreened, 19s. to 20s.; treble nuts, 25s.; doubles, 23s. to 24s.; singles, 17s. 6d. to 19s.; pearls, 12s. 6d. to 15s.; and dross, 14s. to 15s. 6d. all per ton f.o.t. at pit. The demand for house coal is only moderate, and prices are from 25s. to 35s. and under per ton at pit, according to quality. The inquiry on foreign account also is unsatisfactory. Prices are not stable, as quotations are governed by the condition of colliery order books. Some have plenty of orders meantime against contracts, and endeavour to uphold prices for prompt loading, and foreigners are not prepared to pay such firm rates nor shippers to discount colliery quotations. For export screened steam is named 22s.; unscreened, 20s.; treble nuts, 25s.; doubles, 23s.; singles, 20s.; pearls, 19s.; and dross, 14s., all per ton f.o.b. Forth ports.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

As is usual before holidays there is a mild rush to get coals away before Christmas, but it is not on anything like the normal scale. The position of collieries is extremely variable. Some undertakings are very full up with orders, and their output is quite unequal to their requirements. On the other hand, there are some collieries which would be glad of prompt tonnage, thus enabling them to release some of their wagons and relieve them of anxiety regarding the maintenance of work at the pits. It naturally follows that with the conditions in the coalfield so irregular values of coals are in much the same state. On the whole, the tone of the market is not so steady, and there is not the volume of business to hand to keep prices steady, in addition to which supplies of ready tonnage are inadequate. The prospects are that after the holidays rates of freight will show some improvement, while if production of coal expands, which is expected, values of practically all qualities will come down to a more reasonable level. At the same time a sharp falling off in values is not looked for, though so far as large foreign consumers are concerned, they are not prepared to buy far ahead, unless they can get coals at practically the prices which prevailed prior to the coal stoppage. The inquiry is for the most part for single cargoes for prompt loading, and the competition for these orders is already fairly keen.

Egyptian State Railway Contract.

One of the most interesting coal contracts which comes on this market is that for the supply of coals to the Egyptian State Railways. Tenders went in last week for 160,000 tons, and were opened at Cairo on Saturday. These show that the quotations for Welsh coals ranged from 36s. c.i.f. Alexandria to 39s. 3d. c.i.f., while for American coals the lowest tender was 35s. 6d. c.i.f. Hopes are entertained that the business will come to this district, as it is well known that the railways much prefer Welsh coals to any other, and this being the case, the difference of 6d. in favour of American coals should not prevent the order coming to this district. The tenders have to hold good for ten days, so that it will not be known until after the holidays what happens to the business. It is interesting to note that twelve months ago a local firm, Messrs. Watts, Watts and Co., secured the contract for 200,000 tons at the low price of 28s. 9d. c.i.f., while during the national coal stoppage the same firm offered 150,000 tons of Welsh coals at 34s. 6d. c.i.f., or American coals at 36s. c.i.f. Alexandria, the latter coals being shipped. It is evident on the present occasion that the firm which has sent in the lowest price, looks for a substantial reduction in coal values as, basing on 11s. freight, which many will regard as too low to be safe, there is left 25s. to cover the cost of coals, wharfage, insurance, profit, &c., whereas the current market price of the qualities of large that will have to be shipped is round about 28s. to 29s. The firm which put in the lowest tender is Gwilym Owen and Co., of London.

Reduced Trade.

The returns of trade at the leading docks in this district for the year 1926 will make a poor showing as compared with the figures for 1925. It is very clear that the loss of traffic to the Great Western Railway Company in respect of the trade at the ports of Cardiff, Swansea, Newport, Barry, Port Talbot and Penarth, which are under their control, will this year amount to round about 15,000,000 tons. The company's returns for the year to November 28th last reveal that the decline in imports and exports combined reached the enormous figure of 14,099,808 tons, as compared with the same period of 1925. Imports alone showed an improvement, for the main reason that the importation of foreign coals during the stoppage was on such a heavy scale and reached the total of 1,367,750 tons to November 28th last, but on the export side the decline amounted to no less than 14,585,914 tons, the falling off in exports of coal and coke alone reaching the very considerable figure of 13,833,080 tons. As a matter of fact, although the coal stoppage came to an end in the early days of November, the trade of the six ports for the four weeks ended November 28th last was not as good as during the previous four weeks. This is undoubtedly due to the effects of changing over from importing to exporting.

Big Anthracite Deal.

The announcement is authoritatively made that Sir Beddoe Rees, M.P., who is already interested in several anthracite collieries in South Wales, has recently acquired a group of collieries in the Swansea Valley, known as the Abercrave Collieries, the price of purchase being round about one million pounds. The group of collieries includes the Abercrave and International Collieries situate at the top of the Swansea Valley, and the new colliery not long ago opened at Ystalyfera, which was laid out for the production of coals on a substantial scale. It is reported that in a very short time production will be on the basis of 600 tons to 800 tons per day. It is also understood that Sir Beddoe Rees is negotiating for the acquisition of other anthracite collieries in the same district, the combined output of the whole group being in the neighbourhood of about one million tons per annum, which is very important when it is reflected that the total output of anthracite in South Wales is only about five million tons per annum.

Current Business.

There is not a great deal of new business passing on the market at the moment, except in the way of small parcels to enable exporters to complete cargoes which they are endeavouring to get away before the holidays. Some descriptions of coals, such as the highly bituminous sorts, are relatively firmer than others for early loading; but, generally speaking, best Admiralty large coals are round about 30s., and second qualities 28s. to 29s. Best Monmouthshires are also round about the latter basis, while superior smalls are quoted at 22s. 6d. to 23s., lower grades of smalls ruling down to 16s. Patent fuel is quoted at 30s. to 35s., while pitwood has fallen sharply to 40s. to 42s. 6d. owing to the shortage of wagons principally. Hopes are entertained that very shortly the trimmers in this district will come into line on the question of revised working conditions. Over last week-end the trimmers of Cardiff, Penarth and Barry expressed themselves in favour of their representatives continuing negotiations while the Newport men appear to favour the matter being put to the ballot.

ACCORDING to a report from Stockholm the Swedish inventor, Gustaf Ohlsson, has recently carried out trials with a new type of oil engine, in which use is made of a device inside the piston for maintaining constant volume over a certain portion of the stroke. By continual injection of fuel the pressure is increased from ten to thirty atmospheres, after which expansion takes place. A fuel consumption of 150 grammes, or about 0·33 lb., per effective horse-power is claimed. It is further stated that the new system can be applied to large marine oil engines.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (*c.i.f.*)	18/- to 21/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	—	—
No. 1 Foundry	‡4 17 6 to 5 0 0	—
No. 3 Foundry	‡4 12 6 to 4 15 0	—
‡ *For delivery after resumption of work at furnaces.*		
N.E. COAST—		
Hematite Mixed Nos.	(*e*) 4 10 0	4 10 0
No. 1	(*e*) 4 11 0	4 11 0
Cleveland—		
No. 1	(*e*) 4 7 6	4 7 6
Silicious Iron	(*e*) 4 7 6	4 7 6
No. 3 G.M.B.	(*e*) 4 5 0	4 5 0
No. 4 Foundry	(*e*) 4 4 0	4 4 0
No. 4 Forge	(*e*) 4 3 0	4 3 0
Mottled	(*e*) 4 2 0	4 2 0
White	(*e*) 4 2 0	4 2 0
(*e*) *January - February Delivery.*		
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
„ „ Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	—	—
„ Forge	—	—
(3) Derbyshire—		
No. 3 Foundry	4 12 6	—
Forge	—	—
(3) Lincolnshire—		
No. 3 Foundry	4 5 0	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 15 6 (*a*); 4 18 6 (*b*); 5 2 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	11 15 0
Best	—	—
N.E. COAST—		
Common Bars	12 5 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 5 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 5 0 to 11 10 0	
Gas Tube Strip	15 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up	(*d*) 8 2 6	7 0 0
Sections	7 17 6 to 8 0 0	6 5 0
Steel Sheets, under 3/16in. to ¼in.	12 0 0 to 13 0 0	
Sheets (Gal. Cor. 24 B.G.)	—	17 0 0
(*d*) *Official Minimum, actual prices about 5s. more.*		

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 17 6	—
Angles	8 12 6	—
Boiler Plates	12 10 0	—
Joists	8 12 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 12 6	—
Soft Billets	7 12 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0†	—
Light Rails	8 15 0 to 9 0 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 5 0	—
„ (Small Round)	9 10 0	—
Hoops (Baling)	11 0 0	11 0 0
„ (Soft Steel)	10 15 0	10 15 0
Plates	8 15 0 to 9 0 0	
„ (Lancs. Boiler)	11 15 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	9 2 6	—
Intermediate Basic	8 12 6	—
Soft Basic	8 0 0	—
Hoops	12 0 0	—
Soft Wire Rods	10 0 0	—
MIDLANDS—		
Small Rolled Bars	8 15 0 to 9 0 0	
Billets and Sheet Bars	—	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 0 0 to 17 5 0	
Angles	8 12 6 to 8 17 6	
Joists	8 12 6 to 8 17 6	
Tees	9 12 6 to 10 17 6	
Bridge and Tank Plates	—	
Boiler Plates	—	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/6 to 21/6
Block Tin (cash)	307 0 0
„ (three months)	298 0 0
Copper (cash)	57 0 0
„ (three months)	57 15 0
Spanish Lead (cash)	29 3 9
„ (three months)	29 11 3
Spelter (cash)	32 17 6
„ (three months)	32 17 6
MANCHESTER—	
Copper, Best Selected Ingots	64 5 0
„ Electrolytic	64 17 6
„ Strong Sheets	92 0 0
„ Tubes (Basis Price) lb.	0 1 1
Brass Tubes (Basis Price) lb.	0 1 6
„ Condenser lb.	0 1 2½
Lead, English	30 17 6
„ Foreign	29 10 0
Spelter	32 17 6
Aluminium (per ton)	£107

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c. „	£22 0 0	7/3
„ „ 8 p.c. to 10 p.c. „	£20 12 6	6/6
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£36 0 0	12/6
„ „ „ 1 p.c. „	£42 0 0	15/-
„ „ „ 0·70 p.c. carbon	£54 0 0	17/6
„ „ „ carbon free	1/5d. per lb.	
Metallic Chromium	3/- per lb.	
Ferro Manganese (per ton)	£16 for home, £16 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 7 6	scale 5/- per unit
„ „ 75 p.c.	£18 5 0	scale 6/- per unit
„ Vanadium	14/6 per lb.	
„ Molybdenum	5/- per lb.	
„ Titanium (carbon free)	0/11½ per lb.	
Nickel (per ton)	£170	
Cobalt	8/3 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable*).

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	—
„ „ Ell	—
„ „ Splint	—
„ „ Trebles	—
„ „ Doubles	—
„ „ Singles	—
AYRSHIRE—	
(f.o.b. Ports)—Steam	—
„ „ Jewel	—
„ „ Trebles	—
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	—
Screened Navigation	—
Trebles	—
Doubles	—
Singles	—
LOTHIANS—	
(f.o.b. Leith)—Best Steam	—
Secondary Steam	—
Trebles	—
Doubles	—
Singles	—

ENGLAND.

(8) N.W. COAST—	
Steams	28/-
Household	*No quotation.*
Coke	33/-
NORTHUMBERLAND—	
Best Steams	23/-
Second Steams	20/6 to 21/-
Steam Smalls	17/6
Unscreened	20/- to 21/-
Household	30/- to 36/-
DURHAM—	
Best Gas	23/-
Second	19/- to 20/-
Household	30/- to 36/-
Foundry Coke	32/6 to 34/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	34/- to 35/- —
Barnsley Best Silkstone	30/- to 32/- —
Derbyshire Best Brights	30/- to 32/- —
„ „ House	28/- to 30/- —
„ „ Large Nuts	27/- to 29/- —
„ „ Small	22/- to 24/- —
Yorkshire Hards	20/- to 21/- —
Derbyshire Hards	20/- to 21/- —
Rough Slacks	11/- to 12/6 —
Nutty Slacks	10/- to 11/- —
Smalls	3/- to 6/- —
Blast-furnace Coke (Inland)	30/- to 35/- at ovens.
„ (Export) f.o.b.	30/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	30/- to 31/-
Second „ „	29/- to 30/-
Best Dry Large	28/- to 29/-
Ordinary Dry Large	26/6 to 27/6
Best Black Vein Large	28/6 to 29/-
Western Valley Large	28/- to 29/-
Best Eastern Valley Large	28/3 to 29/-
Ordinary „ „	27/6 to 28/6
Best Steam Smalls	20/- to 22/-
Ordinary „	15/- to 20/-
Washed Nuts	31/- to 35/-
No. 3 Rhondda Large	34/- to 35/-
„ „ Smalls	25/- to 26/-
No. 2 „ Large	28/- to 28/6
„ „ Through	24/- to 25/-
„ „ Smalls	19/- to 20/-
Foundry Coke (export)	50/- to 55/-
Furnace Coke (export)	—
Patent Fuel	32/6 to 37/6
Pitwood (ex ship)	37/6 to 40/-
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	47/6 to 50/-
Seconds	42/6 to 45/-
Red Vein	37/6 to 39/6
Machine-made Cobbles	55/- to 57/6
Nuts	60/- to 65/-
Beans	50/- to 52/6
Peas	29/- to 30/-
Breaker Duff	12/- to 12/6
Rubbly Culm	16/- to 17/-
Steam Coals :	
Large	27/6 to 32/6
Seconds	25/- to 27/6
Smalls	14/- to 16/-
Cargo Through	21/6 to 24/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated.

coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. † Latest quotations available.

(*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

A Period of Transition.

IF the franc remains at something like its present level it is probable that values will adjust themselves gradually, although with considerable difficulty, and during the period of transition it is generally recognised that the country will pass through a serious industrial crisis. It is not supposed that the franc will fall again to any appreciable extent, and if, on the contrary, it should undergo another rapid rise, the situation would, of course, become still worse. Everything, therefore, is being done to maintain the present exchange rate until the process of readjustment shall be carried through satisfactorily. Until now the bringing down of prices to the new monetary values seems to be encountering a force of inertia which is causing considerable misgivings for the future. There is a great deal of talk about reduced prices, but they are more apparent than real. In the iron and steel trades there is certainly a reduction of 60f. per ton in the quotations for pig iron, but rolled steel remains practically unchanged, although Paris merchants are offering supplies at something rather less than recently. It is obvious that prices must give way, for the abstention of buyers is so complete that mill and forge owners are doing scarcely any new business at all. Many of them have still a certain amount of work in hand, but as nothing is coming forward to replace it when it is done, producers will be obliged very soon to do what they can to adapt themselves to the new state of things. The decision of the Cartel to restrict the steel production has not influenced consumers, who argue that, as the purchasing power of the franc increases, prices must come down accordingly. There can, however, be no hope of a steady decline in prices unless there is a reduction in wages, which were constantly adjusted to the falling value of the franc, and on the basis of the present exchange they are nearly 30 per cent. higher than they should be. If the prices of commodities do not decline it is because they are based not upon currency values, but upon the wages paid. There can be little hope of wages coming down unless the industrial crisis should enable employers to fix more equitable terms with the men, and it is feared that the crisis will be long and severe before that result can be attained.

The Motor Industry.

One of the first industries to be affected by the rapid monetary deflation was the manufacture of motor cars, which has always depended very largely upon an export trade. The foreign demand for cars has fallen to such an extent that some makers are known to be in serious difficulties. The situation has been entirely reversed, for while French makers are unable to sell cars abroad, except perhaps one or two big firms, the production of which enables them to hold their own to a certain extent, there is a fear that foreign manufacturers may now find their way into this market. The preparations being made by American motor car builders to sell on the Continent are giving rise to great uneasiness. The only way to meet the situation is believed to lie in an amalgamation similar to that effected in the United States, and a beginning has already been made by the carrying out of preliminary negotiations amongst some of the leading firms. The final result will probably be not so much an amalgamation as a co-ordination of interests in the way of standardising as much as possible, centralising the purchase of raw material and organising a general commercial service.

Foreign Trade.

While the returns of foreign trade during the first eleven months of the year continue to show a considerable surplus in the values of imports and exports, it is to be remarked that the values for November, when the monetary deflation began, underwent a notable contraction as compared with the figures for the previous month. There was a decline in imports of 112,000,000f., which was due entirely to raw material, and a contraction in exports of 774,000,000f. The full effect of the monetary appreciation upon the export trade will be observable in the returns for December.

The Steel Cartel.

The meeting in Paris of the representatives of the steel industry in Czecho-Slovakia, Austria, Hungary and Poland did not settle definitely the admission of those countries into the Steel Cartel, but it cleared up most of the debatable points and showed the delegates that there was nothing to gain by holding out for exaggerated claims. The delegates agreed to adhere to the Cartel with a percentage of 7·2 per cent. of the production, representing about 2,000,000 tons a year, which will be in addition to the quota already accorded to the members of the Cartel. A meeting of the Rail Union was also held in Paris, when Germany signed the agreement without obtaining the concessions that rail makers in that country have been holding out for, particularly with regard to the participation of business in the British Commonwealth of Nations. The Rail Union is now practically constituted, and will include the Czecho-Slovakian rail makers who have secured a quota of 4 per cent., which will be in addition to the quantities attributed to the other members.

Railway Accident.

An extraordinary accident occurred last week on the Nord line between Croix-Fonsommes and Fresnoy-le-Grand. Early in the morning a goods train was travelling on an up gradient when a coupling broke. Thirty-four trucks started to run backwards. There was a brakesman in the middle of the train and a lad in the van at the rear. They failed to hold the train with the hand brakes and jumped off on seeing another goods train approaching. In the collision the locomotive kept the rails, but the end trucks turned over on the down line. Before the men could recover from the shock a third goods train arrived on the down line and crashed into the trucks. The locomotive overturned and several trucks fell down an embankment 18ft. high. Under the locomotive were found the bodies of the driver and a brakesman from the second train.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

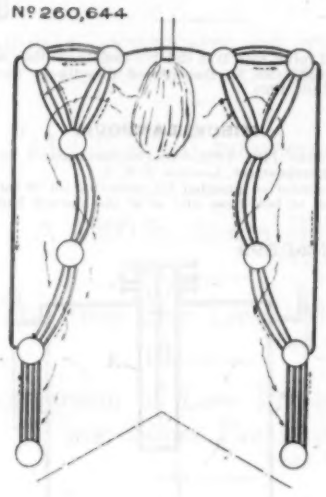
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

260,644. May 11th, 1925.—POWDERED FUEL BOILERS, Simon-Carves, Ltd., and J. H. Brown, 20, Mount-street, Manchester.

A claim is made in this specification for :—"A steam generator for finely divided or gaseous fuel, in which the unburnt fuel is introduced through a burner in the roof of the combustion

Nº 260,644



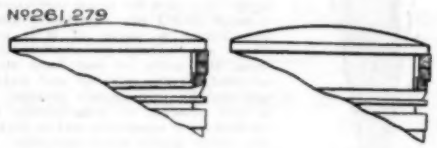
chamber and the completely burnt gases flow in an unbroken path between tubes connecting upper and lower drums, and around said drums, and/or intermediate drums and are withdrawn through outlets at the bottom of the combustion chamber." The drawing is self-explanatory.—*November 11th*, 1926.

INTERNAL COMBUSTION ENGINES.

261,279. May 13th, 1926.—PISTON RINGS, D. Skinner, 3, Rosebery-terrace, Kirkcaldy.

The inventor proposes to use three piston rings in one groove and to provide one ring with a sloping face, to abut against a correspondingly sloping face on the side of the groove. This ring is slightly smaller in diameter than the other two rings. In this way, he says, the abutting sides of the rings act as valve faces, and with the lateral pressure imparted through the taper

Nº 261,279



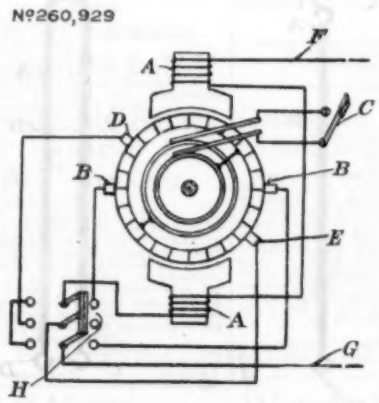
on the abutting sides of the rings or the side of the piston groove in which they are positioned, and with the abutting ends of the rings breaking joint, the groove is automatically and hermetically sealed, thus ensuring that oil or other fluid cannot get access to and so pass from one side of the groove to the other, and further ensuring more effective compression in the cylinder, as two of the rings are always in close contact with the cylinder walls.—*November 18th*, 1926.

DYNAMOS AND MOTORS.

260,929. July 2nd, 1925.—IMPROVEMENTS IN OR RELATING TO ALTERNATING-CURRENT MOTORS, *Standard Telephones and Cables, Ltd., of Connaught House, Aldwych, London, W.C. 2.*

This specification describes a motor which is suitable for

Nº 260,929



accelerating with a high starting torque and subsequently capable of running at a constant predetermined speed. In the drawing the field is shown at A and the brushes at B. Slip rings are also connected to the armature at two fixed points 180 deg. apart, and may be short-circuited by means of a switch C operated by hand or otherwise. Brushes D and E are connected to the terminals of the three-pole double-pole switch and also the brushes B. With the switch H closed to the right-hand position and with the switch C opened the brushes B are connected in series with the field A between the power mains F and G and the machine starts as a series motor. By throwing the switch H to the left and also closing the short circuit switch C the machine may be converted to a synchronous machine after synchronous speed is substantially obtained.—*November 2nd*, 1926.

TELEGRAPHS AND TELEPHONES.

261,060. July 10th, 1925.—IMPROVEMENTS RELATING TO ALLOYS SUITABLE FOR LOADING TELEPHONE AND TELEGRAPH CONDUCTORS, Willoughby Statham Smith, of Benchams, Newton Poppleford, Devonshire, and Henry Joseph Garnett, of Lymne, Solefields, Sevenoaks, Kent.

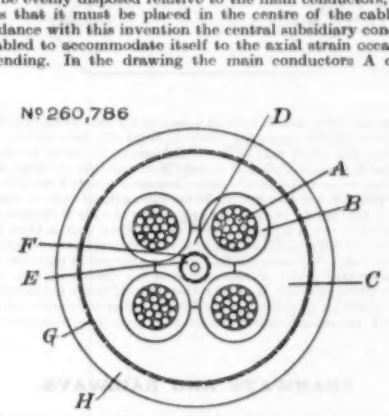
This invention relates to new alloys which have a very high specific resistance and high initial magnetic permeability, and are consequently very suitable in the form of wires, tapes or strips, for loading telephone and telegraph conductors. According to the invention, an alloy is composed of nickel, 62 to 69 per cent.; iron, 11 to 19 per cent.; copper, 6 to 10 per cent.; chromium, 5 to 9 per cent.; with or without the addition of manganese, in quantities not exceeding 0·5 per cent. A specially suitable alloy contains nickel, 65 per cent.; iron, 18 per cent.; copper, 10 per cent.; chromium, 7 per cent.; and manganese, 0·5 per cent. This alloy has an initial permeability of 1200 and electrical resistance of 99 microhms per cubic centimetre.—*November 10th*, 1926.

TRANSMISSION OF POWER.

260,786. November 24th, 1925.—AN IMPROVED MULTI-CORE ELECTRIC CABLE, Charles James Beaver, of Bell-place, Stamford-road, Bowden, Cheshire; and W. T. Glover and Co., Ltd., of Trafford Park, Manchester.

Multi-core cables frequently comprise, in addition to the main working conductors, other conductors for incidental purposes, and in some cases it is necessary that a subsidiary conductor shall be evenly disposed relative to the main conductors, which means that it must be placed in the centre of the cable. In accordance with this invention the central subsidiary conductor is enabled to accommodate itself to the axial strain occasioned by bending. In the drawing the main conductors A consist

Nº 260,786



of twisted strands of copper wire, B are insulations composed of rubber or similar material, C the interspiral packing, and D the centre of the core made of a harder material than the interspiral packing and with surfaces arranged to form beds or cradles to support the insulated main conductors, and they inhibit the tendency for the insulation to become distorted. E is a rubber core which has a hole down the centre to increase the elasticity and is encircled with a braiding or spiral lapping F of copper wires or other conductive material to constitute a subsidiary conductor. G is a conductive layer encircling the packing consisting of a wire braiding, and H a tough rubber sheathing material.—*November 11th*, 1926.

260,837. March 3rd, 1926.—IMPROVEMENTS IN AND RELATING TO INSULATED ELECTRIC CONDUCTORS, The Liverpool Electric Cable Company, Ltd., and Thomas Henry Tweedle, both of Linacre-lane, Bootle, Liverpool.

This invention relates to improvements in insulated electric conductors of the kind in which a single conducting wire or a number of wires are enclosed in insulating material, such as rubber or bitumen, the arrangement having the appearance of a number of single-core cables attached together. According

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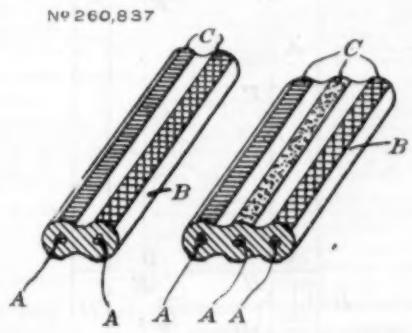


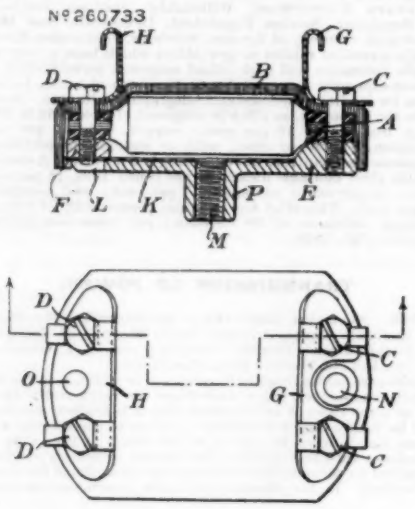
to the invention, a strip or strips of thin distinctly coloured material are connected to the conductors so that the positive and negative conductors may be distinguished. A indicates the wires and B the insulation. C indicates the strips or rubber or other material which are connected to the exterior surface of the insulating material, the strips of one conductor differing in colour from those of another conductor according to the use made of the conductors. There are two other illustrations.—*November 11th*, 1926.

MOTOR CARS AND ROAD TRAFFIC.

260,733. September 25th, 1925.—IMPROVEMENTS IN AND RELATING TO ELECTRIC CONDENSERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, W.C. 2; Leonard Griffiths, 18, Grafton-street, Coventry; and Cecil James Morton, Amubree, St. Paul's-road, Coventry.

This invention relates to electric condensers and has for its object the provision of a simple construction of condenser which is particularly suitable for employment in magnetos.

The condenser comprises a former A on which is wound a number of turns of two layers of tinfoil insulated from each other by paper in the usual manner. After winding, the condenser is vacuum dried, impregnated with paraffin or other wax in vacuo and under pressure, and whilst still warm is formed under a press to the shape shown. The condenser is then placed in a moulded insulation container B and is held in position by screws C D, which screw into metal plates E F respectively. The plate E forms the connection for the contact breaker screw, whilst plate F is simply a clamping plate. Connection is made to the insulated side of the primary winding of the magneto and to the insulated side of the contact breaker by means of a clip G which is secured by the screws C to the container B. The plate E is in metallic contact with the tinfoil of the condenser. A clip H is connected to the earthed side of the

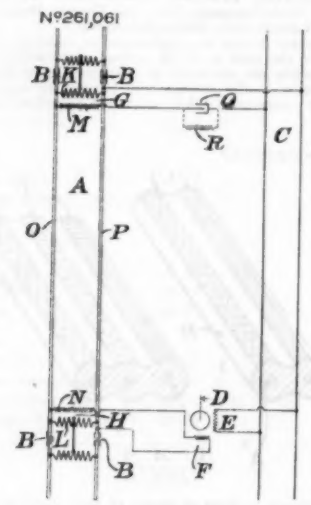


primary winding and is held in position by the screws D, which, together with the clamping plate F, form the connection to the tinfoil on the other side of the condenser. In order to insulate the plate E from the plate F a strip K of cambric or other insulation is interposed and in addition clearance spaces L are provided in the plate E for the screws D on the earthed side of the condenser. By means of suitable apparatus the air is drawn out of the unit through a tapped hole M and molten wax is then forced in under pressure to fill all the spaces between the condenser and its container. The assembled unit is mounted in position in the condenser end plate of the magneto by means of two screws passing through holes N and O, the plate E being insulated from the condenser end plate by cambric or other insulation and by a moulded insulation bush round the boss P.—*November 11th*, 1926.

TRAMWAYS AND RAILWAYS.

261,061. July 10th, 1925.—IMPROVEMENTS RELATING TO TRACK SIGNALLING CIRCUITS AND APPARATUS FOR RAILWAYS, Siemens Brothers and Co., Ltd., of Caxton House, Tothill-street, Westminster, S.W. 1, and James Boot, of "The Cottage," Boxhill-road, Tadworth, Surrey.

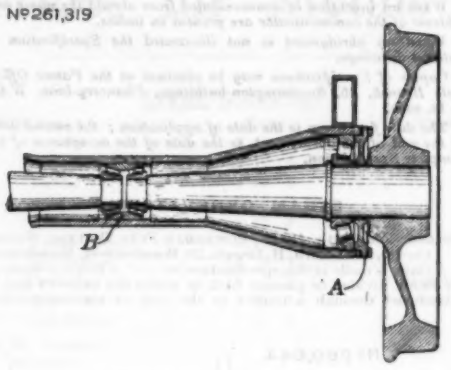
The track section A is insulated from adjacent sections at places B. The alternating-current supply mains are indicated at C. The alternating-current relay D has a winding E connected to the supply mains C and a winding F which is connected to the rails. Impedance bonds G and H at the ends of the section A have main windings K and L and magnetising windings M and N respectively. The mid points of windings K and L are connected to the mid points of the main windings of the adjacent impedance bonds of the next sections. The magnetising windings and connections of the adjacent bonds are not shown.



Winding M is connected to rail O and also to one of the supply mains C. A current limiting condenser Q is included in this connection to guard against excessive current flow, when a vehicle is in the section C. Alternatively, a choke R may be used in place of the condenser. Winding F of the relay D is connected in series with magnetising winding N across the rails O P. When no vehicle is in the section the track signalling current supplied from the mains C passes through the winding M and magnetises the bond, resulting in the production of an electromotive force in the main windng, which opposes flow of current from the rails through the main winding. Likewise, the current from the main C proceeding *vid* the rails flows through winding N to relay D and magnetises the bond H, producing an electromotive force in winding L, opposing the flow of current from the rails.—*November 10th*, 1926.

261,319. September 8th, 1926.—RAILWAY CAB AXLES, The Timken Roller Bearing Company, Canton, Ohio.

In this arrangement each wheel is mounted on a short half-axle and the pairs are assembled in a fixed housing, as shown. Conical roller bearings are provided at each end of each half-axle, and cover plates A are used to hold the parts together.

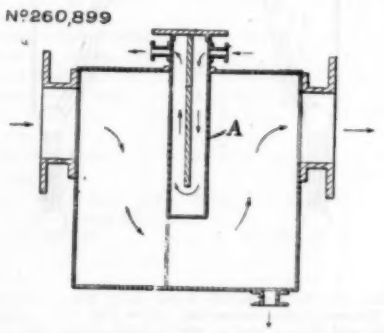


The central roller race B is slidable axially, so that side thrust from one axle can be transmitted directly to the other.—*November 18th*, 1926.

MISCELLANEOUS.

260,899. June 14th, 1926.—OIL SEPARATORS, J. R. Sterling 66, Victoria-street, London, S.W. 1.

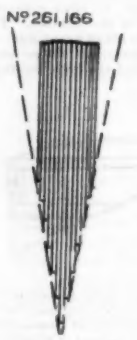
This separator is intended for removing oil or fatty matter from steam or hot gases and is of the normal baffling type,



except that the baffle A is water cooled as shown. It is explained that where steam is the medium to be cleaned the cooling of the baffle should be reduced to a minimum, to reduce the condensation of the steam so far as is possible.—*November 11th*, 1926.

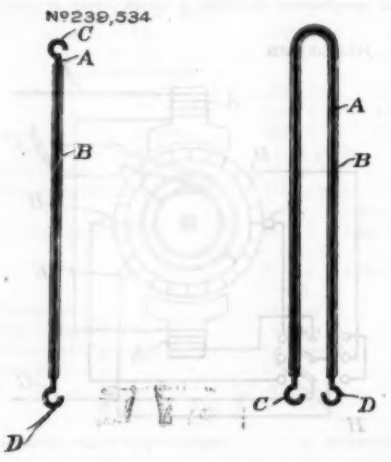
261,166. October 22nd, 1925.—CUTTING AND PIERCING INSTRUMENTS, A. Ignatieff, Helsingfors, Finland.

This invention is really an adaptation of the well-known system of making an agricultural hoe self-sharpening by giving it a hard face and a soft back. The inventor, however, elaborates the idea to cover knives and needles. A knife, for instance, consists of a very hard layer, which lies in the middle plane and to which gradually weaker layers are applied on both sides. These layers may have for usual instruments a gauge of 0·1 mm., or for specially fine knives a gauge of 0·01 mm. They are separately manufactured from the more or less hard steels adapted for the purpose and welded together by any known process. It is also possible to manufacture the hardest layer separately and to deposit the other layers electrolytically. In this manner, by constantly altering the composition of the bath the entire deposit can be produced as a coherent body, the hardness of which decreases outwardly. It is also possible to deposit the layers one after another in different baths of different compositions. In a similar way on the hardest layer the further layers may be added by a metal spraying apparatus.—*November 18th*, 1926.



239,534. September 4th, 1925.—IMPROVED CURRENT CONDUCTORS FOR HIGH-FREQUENCY PURPOSES, Telefunken Gesellschaft für drahtlose Telegraphie m.b.H., of 9, Tempelhofer Ufer, Berlin.

This specification describes a current conductor for high-



frequency purposes which can operate, for example, as choke, transformer, frequency transformer, coupling means, &c.; in short, for all purposes for which the usual transformers or choke coils have usually been employed, such as, for example, for keying signals and telephony. In the drawing on the left A is a copper wire provided with connecting eyes C and D, and B an iron coating less than 0·1 mm. thick. The right-hand drawing shows a bifilar arrangement of the high frequency conductor. The use of an extended conductor, in the form of a straight line, is limited practically by the magnitude of the power to be taken up. Under some circumstances it is preferable to wind the extended conductor upon a former of any suitable shape, so that it requires less space. The law, however, must be followed that this winding does not, as in a simple coil, lead to an increase of the self-induction of the inner conductor, and it is far more desirable to loop the conductor back upon itself. Preferable to the simple extended length with current inlet at one end and outlet at the other end, is the looped back arrangement, with at least one ingoing and one return lead.—*November 18th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TUESDAY, DECEMBER 28TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Christmas lecture, "Nerves and Muscles: How We Feel and Move," by Professor A. V. Hill. 3 p.m.

FRIDAY, DECEMBER 31ST.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria street, London, S.W. 1. Questions and general technical and practical discussions. 7.30 p.m.

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MONDAY, JANUARY 3RD.

INSTITUTION OF AUTOMOBILE ENGINEERS: WESTERN CENTRE.—Merchant Venturers' Technical College, Bristol. Paper, "The Optical Indicator as a Means of Examining Combustion in Internal Combustion Engines," by Professor W. Morgan. 6.45 p.m.

TUESDAY, JANUARY 4TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Soiety of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Place of the Tractor in Soil Cultivation," by Dr. B. A. Keen. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Recent Developments in Motor Cycle Engine Design," by Mr. W. N. Haynes. 7.15 p.m.

TUESDAY TO THURSDAY, JANUARY 4TH TO 6TH.

PHYSICAL AND OPTICAL SOCIETIES.—Imperial College of Science and Technology, South Kensington, London, S.W. 7. Seventh annual exhibition of electrical, optical and other physical apparatus.

THURSDAY, JANUARY 6TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Electrical Equipment of Track on the Underground Railways of London," by Mr. A. R. Cooper. 6 p.m.

FRIDAY, JANUARY 7TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Developments in the Carbonisation of Coal," introduced by Dr. C. H. Lander. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Distortion in Heat-treated Case-hardened Carbon Steels," by Mr. P. J. Haler. 7.30 p.m.

TUESDAY, JANUARY 11TH.

ILLUMINATING ENGINEERING SOCIETY.—E.L.M.A. Lighting Service Bureau, 15, Savoy-street, Strand, London, W.C. 2. Paper, "Floodlighting," by Messrs. W. J. Jones, H. Lingard and T. Catten. 6.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE METROPOLITAN ELECTRIC CABLE AND CONSTRUCTION COMPANY, Ltd., Chadwell Heath, Essex, London, announces that it has acquired as a going concern the wire and cable section of Fuller's United Electric Works, Ltd. The lay-out of the factory has been altered and modernised and various additions and extensions are now in hand.

J. AND E. HALL, Ltd., of 10, St. Swithin's-lane, London, E.C. 4, ask us to announce that they have recently acquired a controlling interest in Medway's Safety Lift Company, Ltd., of 1 and 2, Silex-street, London, S.E. 1, and that the manufacture of that company's electric, hydraulic, and hand power lifts and hoists, both land and marine, has been transferred to their works at Dartford.

WE are informed that a fusion of interests of the Indestructible Paint Company, Ltd., and the Standard Varnish Works (of Great Britain), Ltd., has been effected. The products of the two firms will be manufactured in the factory recently erected at Park Royal, Willesden, N.W. 10, and the two companies will operate under the style and title of "Indestructible Paint and Standard Varnish, Ltd." The combine will be still further strengthened by the financial interest and close co-operation of the London Electric Wire Company and Smiths, Ltd.

A NEW BELT FASTENER.—We have received from Dargue Bros., Ltd., of South-street, West Parade, Halifax, a sample of a new type of fastener for making butt joints in machine belting. It takes the form of three separate pieces; a group of double-sided prongs, which make the actual connection by being passed through holes in the ends of the belt; and a pair of locking plates to prevent the prongs slipping out again. The prongs are spaced about ¼in. apart on a connecting member and are pushed through the holes in the belt from the back. They do not terminate in sharp points, but in more or less knob-like ends, which mesh with "keyholes" in the locking plates. Since the heads engage in the recesses in the small ends of the holes, there is no liability for the plates to drop off if the belt slackens. The plates can be readily removed to enable the belt to be uncoupled. The fastener is well made of stiff steel, and is moderate in price.